1.0 Introduction

Click here to see lessons learned that may apply to the requirements in this LIR.

1.1 Background

Los Alamos National Laboratory established basic standards and requirements for occupational radiation protection in the radiation protection series of LPRs (Laboratory Performance Requirements) and LIRs (Laboratory Implementation Requirements) (LPR402-7**xx.x** and LIR402-7**xx-xx.x** series) originally issued March 6, 1998. The LPRs were developed as part of the DOE Work Smart Standards Process. This LIR consolidates the requirements originally found in the radiation protection LPRs and LIRs into one integrated document. It also incorporates the requirements of the amended 10 CFR Part 835 rule dated November 4, 1998, which will be cited throughout this document.

This LIR complements LPR402-00-00.0, "Worker Health and Safety." Appendix 13 of LPR402-00-00 contains the radiation protection standards originally specified in the LPRs.

How to Use this Document

Each attachment to this LIR represents a chapter of the Laboratory's *Occupational Radiation Protection Requirements Manual* that shall be implemented. For example, Attachment A is Chapter 1 of the manual, which provides requirements that shall be implemented specific to radiation hazard communications. Each chapter is divided into parts, which are subdivided into articles. For example, the number 521 means chapter 5, part 2, article 1. In addition, each 10 CFR 835 requirement or derived requirement is followed by the section number in brackets (for example, [see 835.104]).

Note that in referring to tables, the first digit refers to the chapter where the table can be found, and the second digit designates the order of tables in the chapter (Table 4-1 is the first table in chapter 4, for example). Chapter 1 is Attachment A, chapter 2 is B, and so on.

This LIR shall be effective on the date of issue and shall be fully implemented within 90 days of issue. It replaces the following documents:

Laboratory Performance Requirements

LPR402-701.0 Access Control
LPR402-702.0 ALARA
LPR402-703.0 Area Designations
LPR402-704.0 Contamination Control
LPR402-705.0 Radiological Design and Control
LPR402-706.0 Personnel Dosimetry
LPR402-707.0 Emergency Exposures
LPR402-708.0 Instrumentation
LPR402-709.0 Performance Assessment
LPR402-710.1 Personal Protective Equipment
LPR402-711.0 Planned Special Exposures
LPR402-712.0 Posting
LPR402-713.0 Radiation Hazard Communication
LPR402-714.0 Occupational Dose Limits
LPR402-715.0 Records
LPR402-716.0 Source Control
LPR402-717.0 Storage and Labeling
LPR402-718.0 Training
LPR402-719.0 Workplace Monitoring
LPR402-720.0 Work Planning

Laboratory Procedures/Standards/Manuals

LS107-19.0 Fetal Radiation Protection
LM107-01.1 LANL Radiological Control Manual

Laboratory Implementation Requirements

LIR402-701-01.2 Radiological Access Control
LIR402-702-01.1 ALARA
LIR402-704-01.2 Contamination Control
LIR402-705-01.0 Radiological Design and Control Review
LIR402-706-01.1 Personnel Dosimetry
LIR402-708-01.1 Radiation Instrumentation
LIR402-710-01.2 Radiological Personal Protective Equipment
LIR402-711-01.1 Planned Special Exposures
LIR402-712-01.1 Radiological Posting
LIR402-713-01.1 Radiation Hazard Communication
LIR402-716-01.1 Source Control
LIR402-718-01.1 Radiological Training
LIR402-719-01.1 Workplace Monitoring
LIR402-720-01.1 Work Planning
LIR402-721-01.0 X-Ray-Generating Devices/Facilities

Guidance Note: The "Recommended Major Implementation Criteria for Self-Assessment (Guidance)" may be found at the end of each attachment (A through T) of this LIR.

1.2 In This Document

2.0 Purpose

This LIR specifies occupational radiation protection program requirements that shall be implemented for Laboratory organizations and subcontractors.

3.0 Scope and Applicability

This LIR shall establish requirements for conducting radiological activities at all Los Alamos facilities except those at the Nevada Test Site (NTS). **Guidance Note**: NTS has established its own radiological control program to ensure consistent, high-quality radiological controls for all user organizations at the site.

This LIR shall apply to Los Alamos (University of California) employees, contractors, subcontractors (for example, maintenance subcontractors), visiting scientists, DOE or Department of Defense personnel, members of the public, and any other personnel who perform work at the Laboratory or visit the Laboratory in an official capacity.

This LIR does not address requirements that are specific to the detailed operations of the radiation protection organization (for example, how to perform area contamination surveys); those requirements shall be implemented through ESH-1 (Health Physics Operations), ESH-4 (Health Physics Measurements), ESH-12 (Radiation Protection Services), and ESH-13 (ES&H Training) internal documents.

4.0 Glossary

Acronyms and special terms used in this document are defined in Attachment U.

5.0 Precautions and Limitations

5.1 Precautions

Guidance Note: Failing to follow the requirements of this LIR may result in excessive personnel doses, as well as the spread of contamination beyond intended boundaries. Such failure could also lead to a "noncompliance" with the Los Alamos National Laboratory 10 CFR 835, "Radiation Protection Program" (RPP document), resulting in enforcement actions that could be taken by DOE/EH-10, DOE's Office of Enforcement and Investigation.

5.2 When Requirements Do Not Apply

Except for maintaining individual doses within the limits specified in Table 4-1, chapter 4 (not including planned special exposures and authorized emergency exposures) [see 835.1(c)], the requirements of this LIR shall *not* apply in the following situations:

a. activities that are regulated through a license by the Nuclear Regulatory Commission (NRC) or a state that has an agreement with the NRC, including activities certified by the NRC under section 1701 of the Atomic Energy Act, except as noted in chapters 16 and 18 (Attachments P and R);
b. activities that are conducted under the authority of the director of the Naval Nuclear Propulsion Program, as described in Pub. L. 98-525;
c. activities conducted under the Nuclear Explosives and Weapons Surety Program relating to the prevention of accidental or unauthorized nuclear detonations;
d. radioactive material transportation as defined in this LIR (see Glossary);
e. DOE activities conducted outside the United States on territory that is under the jurisdiction of a foreign government to the extent governed by occupational radiation protection requirements agreed to by the United States and that foreign government; or
f. background radiation, radiation doses received as a patient for the purposes of medical diagnosis or therapy, or radiation doses received from participation as a subject in medical research programs (see Table 4-1, Note 3).

6.0 Implementation Requirements

Requirements that shall be implemented specific to each of the occupational radiation protection programs are located in Attachments A through T of this LIR.

6.1 Integrated Safety Management (ISM) Requirements

The five-step process of integrated safety management must be applied to all aspects of radiological work. Implementing this LIR shall invoke the five-step process. **Guidance Note**: Further information regarding integrated safety management and the five-step process may be found in LPR300-00-00, "Integrated Safety Management."

6.2 Quality Assurance Requirements

Each radiological facility or activity must meet the requirements of LPR308-00-00, "Quality," for radiological work. The ten quality criteria listed in this LPR must be implemented in a graded approach, commensurate with the hazard level (see Article 312 in chapter 3).

6.3 General Requirements

Trained individuals must recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work. The following basic radiological control requirements shall apply to each individual in the workplace.

6.3.1 All employees shall do the following:

- Obey posted, written, and oral radiological control signs, labels, and instructions; hazard control plans (HCPs); and procedures, including instructions on radiological work permits.
- Obey "evacuate" and "stop work" orders promptly, in accordance with facility- or organization-specific procedures.
- Wear personnel monitoring devices when required by radiological work permits, signs, procedures; or by radiological control personnel. Report immediately the loss, damage, or unexpected exposure of personnel monitoring devices or off-scale readings of self-reading dosimeters to ESH-1 (typically, the facility or area radiological control technician [RCT]).
- Participate in internal dosimetry programs as assigned.
- Keep track of their year-to-date radiation exposure status, as well as their external exposure during radiological activities when using direct-reading dosimetry devices.
- Wear personal protective equipment and clothing when required by radiological work permits, HCPs, other work control documents, or postings.

- Minimize the potential spread of radioactive spills and immediately notify ESH-1 (typically, the facility or area RCT) of all spills.
- Avoid contact of skin, clothing, and equipment with contaminated surfaces.
- Place contaminated tools, equipment, and solid waste items on disposable surfaces, such as plastic sheets, when not in use.
- Notify ESH-1 (typically, the facility or area RCT) of faulty radiological control equipment.
- Communicate to ESH-1 (typically, the facility or area RCT) and his or her safety- and environment-responsible line-management chain changes in work, processes, procedures, configurations, or controls that may affect radiological conditions of an operation or area.
- Notify the ESH-12 Radiation Information Management team of off-site occupational radiation exposures so that worker dosimetry records can be updated.
- Ensure that they are mentally alert and in physically sound condition for the work to be performed.
- Limit the amount of material or equipment taken into contaminated areas to minimize radioactive waste and future decontamination.
- Ensure that required materials and equipment are on hand to complete the assigned task, thereby minimizing time and exposure.
- Before entering an area where contamination might be present, ensure that Occupational Medicine (ESH-2) evaluates open wounds, sores, or rashes. If wounded while in this area, exit the area and report the wound to ESH-1 (typically, the facility or area RCT) immediately.

6.3.2 Upon leaving the area, individuals shall

- remove personal protective equipment and clothing to minimize the spread of contamination, and
- frisk or be frisked for contamination when exiting Contamination, High Contamination, Airborne Radioactivity Areas, Underground Radioactive Material Areas (URMAs), and disturbed Soil Contamination Areas; as well as associated Radiological Buffer Areas (RBAs) and Radiological Controlled Areas (RCAs); and immediately notify ESH-1 (typically, the facility or area RCT) if contamination is found.

6.3.3 Individuals shall not

- loiter in radiological areas or
- smoke, eat, drink, or chew in RCAs controlled for contamination, RBAs controlled for contamination, Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, URMAs, Soil Contamination Areas, and Radioactive Material Areas (unless exempted by facility-specific or job-specific requirements).

6.4 Specific Requirements

Specific requirements that shall be implemented are as follows:

Attachment A	Chapter 1	Radiation Hazard Communications
Attachment B	Chapter 2	Response to Radiological Emergencies and Incidents
Attachment C	Chapter 3	ALARA Program
Attachment D	Chapter 4	Dose Standards
Attachment E	Chapter 5	Personnel Dosimetry
Attachment F	Chapter 6	Workplace Monitoring
Attachment G	Chapter 7	Area Designations and Posting
Attachment H	Chapter 8	Radiological Training and Qualifications
Attachment I	Chapter 9	Access Control
Attachment J	Chapter 10	Personal Protective Equipment
Attachment K	Chapter 11	Work Planning
Attachment L	Chapter 12	Radiological Design and Control
Attachment M	Chapter 13	Radiation Protection Instrumentation
Attachment N	Chapter 14	Contamination Control
Attachment O	Chapter 15	External Exposure Control
Attachment P	Chapter 16	Radioactive Sealed Source Accountability and Control
Attachment Q	Chapter 17	Labeling, Storing, and Receiving Radioactive Material
Attachment R	Chapter 18	X-Ray Generating Devices and Facilities Control
Attachment S	Chapter 19	Performance Assurance
Attachment T	Chapter 20	Records and Reports
Attachment U	Glossary	Glossary

6.5 Monitoring Requirements

Monitoring requirements normally performed by Laboratory-qualified radiological control technicians (RCTs) shall be performed by other trained and qualified personnel only when a current Radiological Surveillance Authorization Agreement (RSAA) is in place or when approved by ESH-1 management. **Guidance Note**: Refer to ESH-1-01-03, "Radiological Surveillance Authorization Agreement" for further information regarding RSAAs.

7.0 Documentation

Chapter 20 of this LIR defines the record-keeping requirements that shall be implemented.

8.0 References

Document Ownership—The Office of Institutional Coordination for this document shall be ESH-RPO, the ESH Radiation Protection Office, 667-5296.

Directory of Resources

10 CFR, Part 835, "Occupational Radiation Protection," amended November 4, 1998
10 CFR, Part 830.120, "Quality Assurance"
DOE Order 414.1A, Quality Assurance
LPR402-00-00.0, "Worker Health and Safety"

9.0 Attachments

Attachment A	Chapter 1	Radiation Hazard Communications
Attachment B	Chapter 2	Responding to Radiological Emergencies and Incidents
Attachment C	Chapter 3	ALARA Program
Attachment D	Chapter 4	Dose Standards
Attachment E	Chapter 5	Personnel Dosimetry
Attachment F	Chapter 6	Workplace Monitoring
Attachment G	Chapter 7	Area Designations and Posting
Attachment H	Chapter 8	Radiological Training and Qualifications
Attachment I	Chapter 9	Access Control
Attachment J	Chapter 10	Personal Protective Equipment
Attachment K	Chapter 11	Work Planning
Attachment L	Chapter 12	Radiological Design and Control
Attachment M	Chapter 13	Radiation Protection Instrumentation
Attachment N	Chapter 14	Contamination Control
Attachment O	Chapter 15	External Exposure Control
Attachment P	Chapter 16	Radioactive Sealed Source Accountability and Control
Attachment Q	Chapter 17	Labeling, Storing, and Receiving Radioactive Material
Attachment R	Chapter 18	X-Ray-Generating Devices and Facilities Control
Attachment S	Chapter 19	Performance Assurance
Attachment T	Chapter 20	Records and Reports
Attachment U	Glossary	

Radiation Hazard Communications

Contents

Radiation Hazard Communications

Appendix 1A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

111 General Requirements

Who	Shall
Facility managers and health physicists	Ensure that facility-specific hazards are identified on postings, in required work control documents, and in facility-specific orientations or training.
Safety- and environment-responsible line-management chain	• Assign training to individuals as specified in chapter 8, Radiological Training and Qualification. • Inform Health Physics Operations (ESH-1, typically, the facility or area radiological control technician, RCT) of changes in processes or equipment that could result in a change in radiological conditions or hazards.
Individual workers	• Notify work group supervisors of newly identified hazards. • Complete the assigned training. • Comply with work control documents.
Tour guides and escorts of untrained individuals	• Meet the training requirements of chapter 8. • Communicate radiological hazards to untrained individuals.
RCTs	Identify new or changing radiological hazards and post areas to identify the radiological hazards.
ES&H Training (ESH-13)	• Develop Laboratory-wide radiation protection training. • Assist in the development of facility-specific radiation protection training.

Part 2 Specific Requirements

121 Individuals Who Enter Areas Posted for Radiological Hazards

1. Individuals who enter areas posted for radiological hazards shall be informed or instructed in the following:
   a. risks of exposure to radiation and radioactive materials, including prenatal radiation exposure [see 835.901(c)(1)];
   b. basic radiological fundamentals and radiation protection concepts [see 835.901(c)(2)];
   c. controls, limits, policies, procedures, alarms, and other measures implemented at the facility to control doses, including both routine and emergency actions [see 835.901(c)(3)];
   d. individual rights and responsibilities as related to implementing the facility radiation protection program [see 835.901(c)(4)];
   e. individual responsibilities for implementing ALARA (as low as reasonably achievable) measures [see 835.901(c)(5)]; and
   f. individual exposure reports that may be requested [see 835.901(c)(6)].
2. The extent of these instructions shall be commensurate with the radiological hazard in the area (refer to Appendix 8A, Attachment H).

122 Communicating Information on Hazards

1. Information on radiological hazards shall be communicated either in facility orientations, pre-job briefings, in site and facility radiological training, or through work control documents such as hazard control plans, radiation work permits, and facility work control documents.
2. Individuals who have received initial training in one or more of the three standard DOE courses, namely general employee radiological training (GERT), radiological worker (RW) training, or radiological control technician (RCT) training, shall be considered sufficiently informed on the general radiological hazards, effects, precautions, purposes, responses, and responsibilities required for entry into an RCA.
3. The training shall be received either at Los Alamos National Laboratory or at another site. Also, individuals who have received documented, equivalent training shall be considered sufficiently informed.
4. Radiological hazards that are specific to an area shall be identified on the posting or other warning devices at entrances to the area, or shall be otherwise identified.
5. Individuals who are escorted into the area shall be informed or instructed by a qualified escort. The escort shall ensure that the escorted individual (see definition in glossary) implements the radiation protection requirements for the area being entered. The safety- and environment-responsible line-management chain shall ensure that individuals who require unescorted access are informed by facility-specific orientation or by assigning training as required in chapter 8.

Appendix 1A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radiation Hazard Communications	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.
2. The recommended major implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information.*
   - The level of instruction in each topic listed in Article 121.1 is appropriate for the actual or potential radiological hazards found in the area the individual is to enter. (Article 121.2)
   - These topics are communicated in either facility orientations, pre-job briefings, or in site and facility radiological training, or through appropriate documents. (Article 122.1)
   - Radiological hazards that are specific to an area are identified on the posting or other warning devices at entrances to the area, or will be otherwise identified. (Article 122.4)
   - Individuals who are being escorted have been appropriately informed or instructed by a qualified escort on the topics listed in Article 121.1. (Article 122.5)

Responding to Radiological Emergencies and Incidents

Contents

Responding to Radiological Emergencies and Incidents

Appendix 2A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

211 General Requirements

Who	Shall
Safety- and environment-responsible line-management chain	Ensure that the requirements of this chapter are implemented.
Radiological control technicians (RCTs), incident commanders, or emergency responders	Take radiological emergency/incident actions as prescribed in this chapter.
Radiological workers	Follow the instructions of RCTs, incident commanders, and emergency responders.

Part 2 Responding to Abnormal Situations

Guidance Note: Listed below are typical responses to specific abnormal situations. Facility-specific responses may override the responses provided below. Consult facility-specific emergency response procedures and training for further information. Refer to LIR201-00-04, "Los Alamos National Laboratory Incident Notification Process," for radiological incident determination and notification requirements.

221 Continuous Air Monitor (CAM) Alarm

Responding to a CAM alarm shall include the following actions:

a. If you do not have respiratory protection, you must leave the area immediately, notify an RCT, and remain outside the area until workers and the area are surveyed.

b. If you have respiratory protection, you must follow RCT instructions and not remove the respirator until you are surveyed for contamination by an RCT.

222 High-Radiation Fields

Responding to increasing or unanticipated radiation levels, as identified by a supplemental dosimeter or area radiation monitor alarm, shall include the following actions:

a. Stop work activities and place the work area in a safe condition (for example, secure welding equipment and terminate activities that may result in more severe conditions).

b. Alert others.

c. Exit the area.

d. If necessary, survey yourself for contamination.

e. Notify Health Physics Operations (ESH-1), typically the facility or area RCT.

223 Criticality Alarm

Responding to a criticality alarm shall include the following actions:

a. Immediately evacuate the area, without stopping to remove protective clothing or perform exit monitoring.

b. Report to designated assembly area.

224 Personnel Contamination Monitor Alarm

Responding to a personnel contamination monitor alarm shall include the following actions:

a. Remain in the immediate area.

b. Notify ESH-1 (typically, the facility or area RCT).

c. Minimize cross-contamination if possible (for example, put a glove on a contaminated hand).

d. Follow up in accordance with Article 251 of this attachment.

225 Radioactive Material Spill

For radioactive spills involving highly toxic chemicals, workers shall immediately exit the area without attempting to stop or secure the spill and immediately notify Emergency Management and Response (EM&R) at 667-6211, call the Laboratory's 911 emergency telephone number, or follow facility-specific response plans.

Responding to a spill of radioactive material that does not involve highly toxic chemicals shall include the following actions:

a. Stop or secure the operation causing the spill.

b. Warn others in the area.

c. Isolate the spill area if possible.

d. Minimize individual exposure and contamination.

e. Secure unfiltered ventilation (or request through facility management).

f. Notify ESH-1 (typically, the facility or area RCT).

Part 3 Emergency Exposures

231 Emergency Exposure Limiting Conditions

Guidance Note: Under emergency conditions, individuals can be authorized to receive doses that exceed the limits established in Table 4-1, chapter 4, [see 835.1301 and 1302]. The provisions of this LIR are not intended to limit actions necessary to protect health and safety under these conditions [see 835.3(d)].

1. The risk of injury to individuals involved in rescue and recovery operations shall be minimized [see 835.1302(a)].

2. Incident commanders shall weigh actual and potential risks to rescue and recovery personnel receiving doses in excess of the radiological worker limits in Table 4-1, chapter 4, against benefits to be gained [see 835.1302(b)]. To weigh these risks, incident commanders must either understand the radiobiological effects of radiation exposure themselves or consult experts in radiobiological effects before any decisions are made on emergency exposures.

3. No individual shall be required to perform rescue actions that might involve substantial personal risk (generally accepted to be greater than a 25-rem [0.25-sievert] acute dose to the whole body for the ionizing radiation hazard) [see 835.1302(c)]. The on-scene commander, with advice from available health and safety professionals, shall determine substantial personnel risk from all hazards present before requesting individuals to perform rescue actions. No individual shall be required to perform a rescue action that might involve substantial personal risk—only volunteers will be expected to perform a rescue action that might involve substantial personal risk. The emergency radiation exposures and risk of injury to individuals involved in rescue and recovery shall be kept as low as reasonably achievable (ALARA).

4. Each individual authorized to perform emergency actions that are likely to result in occupational doses exceeding the radiological worker limits in Table 4-1, chapter 4, shall have been trained in accordance with

Article 833, chapter 8, and briefed on the known or unanticipated hazards to which the individual will be subjected [see 835.1302(d)].

5. To evaluate its ability to implement these requirements, the Laboratory shall periodically hold radiological emergency exercises.

232 Emergency Exposure Dose Limits

1. **Guidance Note:** The dose control levels in the table below should be used as guidelines for controlling emergency exposures.

Dose Control Level (external whole-body dose)[a]	Activity Performed	Conditions
To 10 rem (0.10 sievert)	Protecting major property	Where lower dose is not practical
To 25 rem (0.25 sievert)	Lifesaving or protection of large populations	Where lower dose is not practical
Greater than 25 rem (0.25 sievert)	Lifesaving or protection of large populations	Only on a voluntary basis to personnel who are fully aware of the risk involved

[a]The dose limit for the lens of the eye is three times the listed values. The shallow dose limit to the skin of the whole body and the extremities is ten times the listed values. These doses are in addition to and accounted separately from the doses received in accordance with Article 422.

2. An individual whose occupational exposure has exceeded any of the radiological worker limits specified in Table 4-1, chapter 4, as a result of an authorized emergency exposure shall be sent to the Occupational Medicine Group (ESH-2) for evaluation and counseling immediately after the emergency action is complete. The individual shall return to work only when all the following conditions have been met [see 835.1301(a)(1)–(3)]:

   a. Approval is obtained from the individual's division director or equivalent, the ESH Division director, and the DOE Los Alamos Area Office (LAAO) area manager.

   b. The individual receives counseling from the radiation protection organization and ESH-2 regarding the consequences of receiving additional exposure during the year.

   c. The individual agrees to return to radiological work.

   d. A dose management plan is developed and implemented. (Refer to Article 443.1, chapter 4, for further information.)

3. All exposures that exceed the limits specified in Table 4-1, chapter 4, shall be recorded in the affected individual's occupational exposure file [see 835.1301(b)] and reported in accordance with DOE requirements for occurrence reporting and processing.

4. When the conditions under which an authorized emergency dose is received in excess of the limits specified in Table 4-1, chapter 4, have been mitigated (except for planned special exposures, PSEs), the environment- and safety-responsible line-management chain shall notify the DOE/LAAO area manager [see 835.1302(c)].

5. Operations during which an authorized emergency dose is received in excess of the limits specified in Table 4-1, chapter 4, (except for PSEs) shall only be resumed with the approval of the DOE/LAAO area manager [see 835.1301(d)].

Part 4 Responding to Personnel Injuries in Areas Posted for Radiological Purposes

In responding to personnel injuries that occur in areas posted for radiological hazards, the following actions shall be taken.

241 Serious Injuries

1. For serious injuries (with the potential to cause loss of life, disability, or serious pain), first aid shall take priority over radiological concerns. The immediate health of the individual, rather than the radiological hazards to which he or she is exposed, shall be the primary consideration. Specific actions shall be as follows:
   a. Call 911 and request medical assistance.
   b. Administer first aid (to the extent possible by the responder, given previous training and experience)
   c. Contact an RCT.
2. Any of the following (not an all-inclusive list) shall be considered a serious injury:
   a. head or neck injury,
   b. penetrating injury (except for a minor puncture wound to an extremity),
   c. loss of consciousness,
   d. disorientation,
   e. convulsion,
   f. loss of sensation,
   g. loss of motor function,
   h. limbs at abnormal angles,
   i. amputations,
   j. burns of the face, hands, feet, or genitals,
   k. burns larger than the palm of the hand,
   l. inhalation of any toxic substance,
   m. abnormal breathing patterns,
   n. extensive bleeding,
   o. apparent large bone fractures,
   p. electric shock, and
   q. avulsion.

242 Minor Injuries

For minor injuries, radiological control shall take priority, and personnel shall take the following actions:

1. Contact an RCT immediately.
2. Follow the RCT's instructions.
3. Have any wound occurring in areas controlled for contamination surveyed for radioactive contamination.
4. Contact the immediate supervisor of the individual who has a potentially contaminated wound.
5. Administer first aid (to the extent possible by the responder) after decontamination (see Article 252 below).
6. Have the individual report to ESH-2.

Part 5 Handling Radiologically Contaminated Personnel

251 Skin and Clothing Contamination

1. When personnel detect skin and clothing contamination—except for anticontamination clothing expected to be contaminated—they shall promptly notify ESH-1 (typically, the facility or area RCT) in accordance with facility-specific procedures. In doing so, they shall take precautions as outlined in those procedures to minimize the spread of contamination and intakes.

   Guidance Note: Levels of skin contamination that trigger the need for dose assessments are documented in ESH-1-09-05, "Responding to External Personnel Contamination." The trigger level for assessing skin dose is 0.1 rem (1 milliseivert [mSv]).

2. The extent of skin and clothing contamination shall be determined before decontamination procedures are initiated.

3. Personnel shall be decontaminated immediately by simple, noninvasive methods.

4. Contaminated personnel who cannot be readily decontaminated by simple, noninvasive methods shall be referred to ESH-2.

5. Individuals with enough skin contamination to trigger the need for dose assessment shall be informed of the initial dose estimate to their skin as soon as practicable by Radiation Protection Services (ESH-12).

252 Contaminated Wounds

Contaminated wounds shall be treated in the following manner.

1. Health Physics Measurements (ESH-4) shall monitor wounds and associated bandages for contamination, including alpha emitters if applicable.

2. ESH-4 shall identify the radionuclides involved.

3. ESH-2 shall medically determine the need for therapeutic intervention such as the use of blocking or chelating agents, or excision of a wound.

4. ESH-12 shall initiate required bioassay monitoring.

5. ESH-2 shall determine the need for restrictions related to radiological work.

Part 6 Accidental Exposures

261 Exceeding Dose Limits

1. Individuals who receive unauthorized exposures (that is, other than PSEs and authorized emergency exposures) that exceed any of the limits in Table 4-1, chapter 4, as a result of an accident or incident shall not be allowed to receive any additional occupational exposure during the current year unless a specific exemption has been granted by DOE through the 10 CFR 820 exemption process.

2. When preliminary data indicate that an individual has exceeded a dose limit because of an accidental intake of radioactive material (including the dose for the current calendar year), the individual shall not be allowed to enter any area posted for radiological hazards. Only when it can be reasonably ascertained that the intake did not result in the individual's receiving a dose in excess of the dose limit shall the individual be allowed to re-enter these areas. This determination shall be documented by the ESH-12 Dose Assessment Team.

262 Dose Management Plan

1. **Guidance Note**: In the event of a radioactive material intake, a "return to work" meeting should be held before the individual returns to work. At the meeting, those who were involved in the event, their supervisors, ESH-1, the Radiation and Protection Program manager, and ESH-12 Dose Assessment team members should determine the next required steps.

2. A "dose management plan" shall be established to ensure that the individual does not exceed the occupational dose limits in Table 4-1, chapter 4.

3. The decision to return an individual to work following such an event must be carefully considered. The cause of the intake must be mitigated, the individual's right to continue earning a wage must be considered, and the perspectives of all parties involved must be considered.

4. **Guidance Note**: Return-to-work considerations may include the need to avoid additional dose or intakes that may confound the dose assessment.

263 Conditions for Returning to Work

1. An individual whose occupational exposure has exceeded or may have exceeded any of the limits specified in Table 4-1, chapter 4, as a result of an incident or accident shall be sent to ESH-2 for evaluation, possible treatment (for example, chelation), and counseling. If a dose limit has been exceeded, the individual shall return to work only when all the following conditions have been met:

   a. An approved exemption from the dose limit requirements of Table 4-1 (see Article 422) has been granted (see Article 261.1 above).

   b. Approval is obtained from the individual's division director or equivalent, the ESH Division director, and the DOE/LAAO area manager.

   c. The radiation protection organization and ESH-2 counsel the individual on the consequences of receiving additional exposure during the year.

   d. The individual agrees to return to radiological work.

   e. The conditions under which the exposure was received in excess of the limits have been mitigated, and this information has been provided to the DOE/LAAO area manager.

2. When the dose in excess of the limits specified in Table 4-1, chapter 4 (except for PSEs), has been specifically linked to an operation, the operation during which the dose was received shall be resumed only with the approval of the DOE/LAAO area manager.

Appendix 2A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Responding to Radiological Emergencies and Incidents	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.
2. The recommended major implementation criteria for self-assessment of this chapter are the following.
   Note: The article number is given with each bullet to help the reader find more information.

   - Incident commanders understand or consult experts on the radiobiological effects of radiation exposure. (Article 231.2)
   - Incident commanders weigh cost/risk benefits (personnel doses to benefits to be gained in a rescue attempt) to rescue and recovery personnel. (Article 231.2)
   - Emergency radiation exposures and risk of injury to rescue and recovery personnel are kept as low as reasonably achievable (ALARA). (Article 231.3)
   - Rescue volunteers know the hazards involved in the operation before they receive the anticipated exposure. (Article 231.4)
   - Laboratory emergency exercises are conducted and periodically include radiological emergencies that test the above criteria. (Article 231.5)
   - Individuals who exceed the occupational limits in Table 4-1 are sent to ESH-2 after the emergency action is complete. (Article 232.2) These exposures are recorded in the affected individual's occupational exposure file and reported in accordance with DOE requirements. (Article 232.3) Occurrence reports associated with the emergency and/or accident are prepared and submitted in accordance with DOE requirements.
   - When emergency exposure conditions are mitigated, the environment- and safety-responsible line-management chain notifies the DOE/LAAO area manager, and operations associated with the overexposure are resumed with approval by the DOE/LAAO area manager. (Articles 232.4 and 232.5)
   - For serious injuries, first aid takes priority over radiological concerns. (Article 241.1)
   - Skin and clothing contamination—except for anticontamination clothing expected to be contaminated—is promptly reported to ESH-1 in accordance with facility-specific procedures. (Article 251.1)

ALARA Program

Contents

ALARA Program

Appendix 3D of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 ALARA Program General Requirements and Responsibilities

311 General Requirements

Radiological work at the Laboratory shall be conducted so that radiation doses resulting from the work are *as low as reasonably achievable* (ALARA). The ALARA process of managing radiation exposures shall be a fundamental requirement of every radiological control program. To provide an objective basis for implementing and assessing ALARA principles, each organizational ALARA program shall

- establish commitment and participation at all levels of management and the work force;
- require training for managers and workers involved with radiological operations;
- ensure that required methods for maintaining occupational exposures ALARA are integrated into the design of facilities and operations and into the planning of work;
- provide direction for maintaining occupational exposures ALARA that is commensurate with expected radiological conditions;
- integrate measures for maintaining occupational exposures ALARA into specific operations, with design taking precedence over administrative controls;
- maintain ALARA documentation; and
- periodically document reviews of possible improvements to operations and maintenance practices, including cost/benefit considerations with the objective of optimizing collective dose.

312 Graded Approach

1. The Los Alamos ALARA Program uses a graded approach, so the scope of the program shall be commensurate with the potential for radiation exposure. Organizations shall be categorized according to high-, medium-, and low-dose criteria. The degree of participation in program requirements shall be based on how the organizations have been categorized. This chapter describes the minimum requirements for a graded approach to ALARA. **Guidance Note**: Additional radiation protection measures and ALARA actions may be implemented at the discretion of organizations performing the work, and with the support of radiation protection personnel.
2. The basis for determining the effort that must be applied to the graded program is shown in Appendix 3A of this chapter.

Part 2 Program Elements

321 Policy and Management Commitment

1. Management commitment to the ALARA Program must be the critical element for ensuring its success. Division directors, program directors, and office directors shall
   a. support and promote ALARA policy and principles and
   b. ensure that Laboratory and organization ALARA program requirements are implemented.
2. Affected group leaders shall support ALARA principles and programs, including allocating resources; providing for training so that radiation workers are qualified to apply ALARA practices; and ensuring that assignments and actions are taken to fulfill required program elements as described in Appendix 3A (this chapter).

3. Division directors, facility managers, and support service personnel affected by the ALARA Program shall also support the ALARA Program according to their responsibilities and authorities.

322 ALARA Training

An individual's ALARA training shall be commensurate with the individual's assigned role in the workplace, whether team leader, supervisor, or any other worker. The individual shall be trained in accordance with the requirements of the Laboratory radiation protection training program as described in chapter 8 of this LIR.

323 ALARA Procedures

1. Organizations shall incorporate ALARA measures into their work procedures if (1) the organization works with dispersible radioactive materials or contaminated systems, or (2) organization doses are likely to exceed the following:
   a. 1-person-rem (0.01-person-sievert) collective dose,
   b. 0.5-rem (5-mSv) individual dose, or
   c. 0.1-rem (1-mSv) average individual dose.
2. Each organization's work procedures shall include required measures for optimizing radiation exposure (for example, measures related to minimizing time spent in the area, maximizing distance from the source of radiation, and increasing shielding) and for minimizing the spread of removable contamination.

324 ALARA Goals

1. ALARA goals shall be developed as a tool to measure performance and to encourage improvement. Group leaders shall develop organizational goals taking operational history and future production, maintenance, and research into consideration. Organization goals shall be specific, quantitative, and realistic.
2. At a minimum, ALARA goals shall include collective exposure for the year for each organization involved in radiation work totaling more than
   a. 1-person-rem (0.01-person-sievert) collective dose,
   b. 0.5-rem (5-mSv) individual dose, or
   c. 0.1-rem (1-mSv) individual dose.
3. These ALARA goals shall be submitted to ESH-12. The Laboratory ALARA Steering Committee shall approve these individual organizational ALARA goals and any required changes to the goals (for example, work load adjustments). These goals shall be tracked as part of the Laboratory's Appendix F performance measures.

325 ALARA Design Reviews

Design reviews for ALARA shall be performed in accordance with the requirements described in chapter 12 of this LIR for modifications to existing radiological facilities and new facilities.

326 ALARA Reviews of Radiological Work

Formal ALARA reviews shall be carried out for radiological work or experiments that satisfy the criteria established in Appendix 3B unless organization-specific criteria are present. Appendix 3B lists the requirements that shall implement the criteria that trigger an ALARA review. The five-step process for safe work practices shall include the following three parts:

a. pre-job planning and dose estimation;
b. implementing ALARA control measures (use Appendix 3C, ALARA Review Checklist, for required ALARA techniques) and dose-tracking; and

c. post-job review (see Article 1933, chapter 19 for further information).

327 Cost-Benefit Analysis

1. Cost-benefit analysis shall be used to make decisions for ensuring that the most cost-effective dose-reduction measures are implemented. **Guidance Note**: Cost-benefit analysis typically applies monetary equivalents of $1,000 to $10,000 per person-rem (0.01 person-sievert) with the recommended nominal value being $2,000 per person-rem.

2. Cost-benefit analysis shall be performed by the radiation protection organization at the request of the safety- and environment-responsible line-management chain (or ESH-1) whenever the cost of an ALARA measure exceeds $50,000 or the collective dose estimated is greater than 5 person-rem (0.05 person-sievert).

328 ALARA Performance Assessment

An organization's performance in implementing required ALARA program elements (see Appendix 3A) shall be assessed at least once every 36 months by Internal Assessments (AA-2). Reports of organization/facility ALARA program successes and shortfalls shall be reviewed by the Radiation Protection Program manager. A closed-loop system for verifying the closure of corrective actions shall be implemented in accordance with Article 1921.3 in chapter 19.

329 ALARA Committees and Coordinators

1. The need for a group or division ALARA committee and ALARA coordinator shall be commensurate with the organization's potential for radiation exposure. Appendix 3A shows the requirements that shall be implemented to determine the need for group or division ALARA committees and coordinators.

2. When required, the safety- and environment-responsible line-management chain for the organization (typically a group or division) shall assign an individual to the position of line organization ALARA coordinator. This person shall be responsible for implementing required program elements as listed in Appendix 3A. The line organization ALARA coordinator shall also do the following:

   a. review plans for nonroutine radiation work that has a potential for medium or high dose, and integrate the required ALARA measures into the work;

   b. maintain ALARA documentation in accordance with the records requirements of Article 2031, chapter 20; and

   c. ensure that ALARA considerations are incorporated into training, operations, procedures, maintenance, facility designs, and emergency response plans.

3. When required, the safety- and environment-responsible line-management chain for the organization (typically a group or division) shall determine the ALARA committee membership and operating charter. The line organization ALARA committee shall assist the line organization ALARA coordinator with implementing the required ALARA program elements. The line organization ALARA committee shall also

   a. review the organization's overall implementation of the ALARA Program, including results of reviews and audits, trends in radiation exposure for completed work, and ALARA plans and goals for future radiation work;

   b. recommend to the group or division leader improvements and initiatives that are needed to demonstrate a successful ALARA program; and

   c. meet according to a predetermined schedule and document the proceedings of the group or division ALARA committee meeting.

4. To oversee and evaluate the implementation of the Laboratory's ALARA program, a Laboratory-wide ALARA Steering Committee shall be chartered by the deputy Laboratory director for operations. This committee shall advise the Laboratory Director and Laboratory leaders of the effectiveness and progress of the program and participate in the establishment, review, and approval of ALARA goals for those organizations

requiring goals. This committee shall comprise the Laboratory Radiation Protection Program manager as the chairperson and representatives from divisions that have had external collective-dose totals greater than 1.0 person-rem (0.01 person-sievert) in the previous calendar year.

Part 3 Documentation

331 ALARA Documentation

ALARA records (such as plans, reviews, meeting notes, and training forms) that demonstrate the implementation of required program elements shall be retained by the organization generating the records, along with reports of actions taken to maintain, in accordance with Article 2031 in chapter 20, radiation exposures ALARA.

Appendix 3A
Levels that Shall be Used for the Graded Approach to ALARA

Category Criteria

Organizations shall be categorized by dose potential as shown in the table below.

This level of organization . . .	performs radiation work processes that could result in this annual dose:
1 (high-potential-dose)	>5 person-rem (0.05-person-sievert) collective, >0.5-rem (5-mSv) individual, or >0.1-rem (1-mSv) average individual
2 (medium-potential-dose)	>1 person-rem (0.01 person-sievert), but 5 person-rem (0.05 person-sievert) collective, >0.1-rem (1-mSv) but 0.05-rem (5-mSv) individual, or >0.05-rem (0.5-mSv) but 0.1-rem (1-mSv) average individual
3 (low-potential-dose)	1-person-rem (0.01 person-sievert) collective, 0.1-rem (1-mSv) individual, or 0.05-rem (0.5-mSv) average individual

Implementing Requirements

Depending on how an organization's operations are categorized, requirements shall be implemented as shown in the table below.

Program Elements	Level 1	Level 2	Level 3
Management commitment (Article 321)	Required	Required	Required
Training (Article 322)	Required	Required	Required
Procedures (Article 323)	Required	Required	Not required
ALARA goals (Article 324)	Required	Required	Not required
Design reviews (Article 325)	Facility-specific	Facility-specific	Facility-specific
ALARA reviews[1] (Article 326)	Activity-specific	Activity-specific	Activity-specific
Cost-benefit analysis (Article 327)	Activity-specific	Activity-specific	Activity-specific
Performance assessment (Article 328)	Required	Not required	Not required
ALARA committees and coordinators (Article 329)	Required	Not required	Not required
Documentation (Article 331)	Required	Required	Required

[1]The basis for performing a formal ALARA review is shown in Appendix 3B of this chapter.

Appendix 3B
ALARA Reviews of Radiation Work

ALARA Trigger Levels

Radiation work permits (RWPs) and hazard control plans (HCPs) that are implemented to control routine radiological work (see glossary) shall be used to provide a convenient means to perform an ALARA review of work tasks.

A formal ALARA review must be performed for "special radiological work" (see glossary) that exceeds trigger levels. The safety- and environment-responsible line-management chain, in consultation with the ALARA coordinator, facility manager, and/or ESH-1, shall establish the criteria to trigger a formal ALARA review.

Guidance Note: The recommended radiological criteria and sample trigger levels appear below.

Radiological Condition	Trigger Level
Estimated individual dose for a job	0.5-rem (5-mSv) whole-body EDE (external) 5-rem (0.05-sievert) partial-body (extremity) or shallow
Estimated collective dose for a job	1 person-rem (0.01 person-sievert) (external) 10 person-rem (0.1 sievert) shallow
Work area airborne radioactivity concentrations	25 DAC averaged over 8 hr (200 DAC-hr)
Work area removable contamination levels	1000 × Table 14-1, chapter 14 values
Work area dose rate	1-rem/hr (0.01-sievert/hr) whole body 10-rem/hr (0.1-sievert/hr) extremity

ALARA Review Process

The following process shall be implemented when performing a formal ALARA review.

Step	Action	Details
1	Plan the job and estimate the dose.	Detail the work and dose estimations. Determine whether a formal ALARA review is required.
2	Implement ALARA control measures (use Appendix 3C) and track dose	If a review is required, incorporate ALARA measures into the work. Track individual and collective doses and compare to the estimated dose to determine if the ALARA measures are effective.
3	Do post-job review	If actual doses fall outside the range of ± 25% of pre-job estimates, or if significant problems or successes were learned, then perform and document a formal post-job review on improvements to optimize doses for similar future work (see Article 1933, chapter 19, for further information on post-job reviews).

Appendix 3C
ALARA Review Checklist

Form 2051, 12/22/2000

List ALARA recommendations for job identified on reverse side.

Prepared by _____ Date _____

Attach all supporting review documentation to this form and file with the RWP/HCP package.

Appendix 3D
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
ALARA Program	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment in this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - The individual's ALARA training is commensurate with the individual's assigned role in the work place. (Article 322)
   - Organizations that exceed dose trigger levels in Articles 323 and 324 incorporate ALARA measures into their work procedures and develop ALARA goals, respectively. (Articles 323 and 324)
   - Formal ALARA reviews are performed in accordance with the requirements of Appendix 3B. (Article 326)
   - Periodic assessments of the ALARA program are performed. (Article 328)
   - Management takes action based on the results of the periodic ALARA program assessments. (Article 328)
   - Documentation generated for the ALARA program is maintained. (Article 331)

Dose Standards

Contents

Dose Standards

Appendix 4E of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

411 General Requirements

Who	Shall
Division directors, program directors, office directors, and group leaders	Determine the need for a planned special exposure (PSE) and request a PSE when required.
Environment, Safety, and Health (ESH) Division director	Request DOE approval for the PSE.
Radiation Protection Program manager	Provide a technical merit review and recommendation to the ESH Division director regarding a PSE.
Safety- and environment-responsible line-management chain	Ensure that workers, minors, and on-site members of the public under their purview do not exceed specified dose limits.
Individual radiation workers and general employees	Monitor their doses throughout the calendar year and during radiological activities to ensure that specified dose limits are not exceeded. They shall also know what dose limits apply to them and where to obtain dose reports. (Go to http://eshdb.lanl.gov/cgi-bin/esh12/esh12menu.cgi).
Health Physics Operations (ESH-1)	Provide hazard analysis and field technical support for routine and planned special exposures.
Occupational Medicine (ESH-2)	Provide medical counseling for PSEs, authorized emergency exposures, and other exposures that warrant medical attention.
Radiation Protection Services (ESH-12)	• Provide dose history information. • Provide dose determinations and counseling. • Assist in ALARA (as low as reasonable achievable) analyses and radiological job reviews. • Maintain dose records.

Part 2 Dose Limits

Unless otherwise indicated, dose limits shall be stated in terms of the total effective dose equivalent (TEDE), which is the sum of the doses received from internal and external sources.

421 Lifetime Dose Limit

Guidance Note: The Laboratory has established a lifetime dose limit (cumulative TEDE) of N rem, in which N is the age of the individual in years. Article 443, chapter 4, discusses special control levels for radiological workers who have lifetime doses exceeding N rem.

To ensure implementation of the lifetime dose limit, efforts must be made to determine the lifetime occupational dose of individuals expected to receive more than 1 rem (0.01 sievert) in a year. The lifetime occupational dose shall be determined by summing all occupational internal and external doses received during the individual's lifetime at all facilities.

422 Occupational Dose Limits

1. Occupational dose limits are provided in Table 4-1 below and shall not be exceeded [see 835.202(a)(1)-(4)]. All occupational doses received during the current year (including off-site occupational dose), except the dose resulting from PSEs and authorized emergency exposures, shall be included when demonstrating compliance with Table 4-1 limits [see 835.202(b) and 702(d)]. **Guidance Note**: If formal records of an individual's previous occupational dose during the year cannot be obtained, a written estimate signed by the individual may be accepted [see 835.702(d)].
2. The occupational dose limits provided in Table 4-1 below shall apply to all workers performing radiological work. However, general employees who have not completed required training and examinations shall not be permitted unescorted access to any radiological area [see 835.901(b)].

Table 4-1 Summary of Occupational Dose Limits

Type of Exposure	Limit
Radiological worker: whole body (internal + external) (TEDE) [see 835.202(a)(1)]	5 rem/year (0.05 sievert/year)
Radiological worker: lens of the eye (external) [see 835.202(a)(3)]	15 rem/year (0.15 sievert/year)
Radiological worker: skin and extremities (external shallow dose) [see 835.202(a)(4)]	50 rem/year (0.5 sievert/year)
Radiological Worker: Any organ or tissue (other than lens of eye) (internal + external) [see 835.202(a)(2)]	50 rem/year (0.5 sievert/year)
Declared pregnant worker: embryo/fetus (internal + external) [see 835.206(a)]	0.5 rem/gestation period (5 mSv/gestation period)
Minors: whole body (internal + external) (TEDE) [see 835.207]	0.1 rem/year (1 mSv/year)
Minors: lens of the eye, skin, and extremities [see 835.207]	10% of radiological worker limits
General employee (nonradiological worker): whole body (internal + external) (TEDE)	0.1 rem/year (1 mSv/year)

Notes

1. The weighting factors in Appendix 4A shall be used in converting organ dose equivalent to effective dose equivalent for the whole body dose [see 835.203(b)].
2. The annual limit of dose to "any organ or tissue" shall be based on the committed dose equivalent to that organ or tissue resulting from internally deposited radionuclides over a 50-year period after intake plus any deep dose equivalent to that organ from external exposures during the year [see 835.202(a)(2)].
3. Exposures resulting from background radiation, as a patient undergoing therapeutic and diagnostic medical procedures, or participating as a subject in medical research programs, shall not be included in either personnel radiation dose records or assessment of dose against the limits in this Table [see 835.202(c)].
4. Whole-body dose (TEDE) shall be the effective dose equivalent from external exposures + committed effective dose equivalent from internal exposures [see 835.2(a)].
5. Lens-of-the-eye dose equivalent shall be the dose equivalent from external exposure determined at a tissue depth of 0.3 cm [see 835.2(a)].
6. Shallow dose equivalent shall be the equivalent from external exposure determined at a tissue depth of 0.007 cm [see 835.2(a)].

423 Dose Limits for Members of the Public

Members of the public permitted access to Radiological Controlled Areas (RCAs) at the Laboratory shall be limited to an annual radiation dose of 0.1 rem (1 mSv) from the sum of doses received from internal and external radiation sources [see 835.208].

424 Embryo/Fetus Dose Limits

After a female worker voluntarily notifies her employer in writing that she is pregnant, for the purposes of fetal/embryo protection, she shall be considered a declared pregnant worker. **Guidance Note**: This declaration may be revoked, in writing, at any time by the declared pregnant worker [see 835.2(a), Declared pregnant worker].

1. For a declared pregnant worker who chooses to continue work that involves occupational exposure, the following shall apply:

   a. The dose limit for the embryo/fetus from conception to birth (entire gestation period) as a result of the occupational exposure of the declared pregnant worker shall be 0.5 rem (5 mSv) [see 835.206(a)]. The dose to the embryo/fetus shall be equal to the sum of doses received from external doses, sources inside the mother, and sources inside the embryo/fetus.

   b. Measures shall be taken to avoid substantial variation above the uniform exposure rate necessary to meet the 0.5 rem (5 mSv) limit for the gestation period [see 835.206(b)]. **Guidance Note**: Avoid exceeding 0.05 rem (0.5 mSv) per month for the declared pregnant worker.

2. If the dose to the embryo/fetus is determined to have already exceeded 0.5 rem (5 mSv) when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks in which additional occupational radiation exposure is likely during the remainder of the gestation period [see 835.206(c)].

3. The declaration of pregnancy shall be voluntary. However, an employee who wishes to declare her pregnancy must do so in writing to her supervisor, to ESH-12, or to ESH-2. The group or individual who first receives the written pregnancy notification shall send a copy to the persons in charge of fetal protection in the other groups. Once the pregnancy is declared, the Laboratory shall provide a radiation protection program that enables the declared pregnant worker to reduce the occupational exposure to her embryo/fetus. Once the employee has declared her pregnancy in writing, her supervisor must take an active role in participating in the more stringent radiation protection program for the pregnant worker.

   Guidance Note: The pregnant worker may at any time withdraw her declaration of pregnancy, thus terminating any workplace restrictions.

4. A withdrawal of declaration must be made in writing to ESH-2 or ESH-12.

Part 3 Planned Special Exposures (PSEs)

431 Introduction

Guidance Note: In an exceptional situation, a radiological worker can be authorized to receive a PSE that exceeds the values of the radiological worker limits specified in Table 4-1 above.

PSEs shall be accounted for separately from doses received under the Table 4-1 limits above [see 835.204].

432 PSE Limiting Conditions

1. A PSE shall be considered only in an exceptional situation, such as when alternatives that might prevent a radiological worker from exceeding the radiological worker limits in Table 4-1 above are unavailable or impractical [see 835.204(a)(1)].

2. The group leader or equivalent (and employer, if the direct employer is not UC) shall justify and request the PSE in writing (see Appendix 4B in this chapter) [see 835.204(a)(2)]. The group leader or equivalent shall forward the completed request to the next level of Laboratory line management.

433 PSE Dose Limits

1. Before assigning an individual to participate in an authorized PSE, the individual's dose from all previous PSEs and all doses in excess of the occupational dose limits shall be determined [see 835.204(b)]. The requester shall provide the individual's name, Z number, and anticipated PSE dose on the "Previous Doses and Dose Limits" section of the form in Appendix 4B. ESH-12 shall provide written records of all previous PSE doses and all doses in excess of the occupational dose limits by filling out the "Previous Doses and Dose Limits" section of the form. ESH-12 shall complete the "Dose Limits from PSEs" section of the form and shall indicate the eligibility of each individual.
2. An individual shall not receive a PSE that, in addition to the doses determined in Article 433.1 (this chapter), would result in a dose exceeding the following [see 835.204(c)(1)-(2)]:
   a. in a year, the numerical values of the radiological worker dose limits established in Table 4-1 above, and
   b. over the individual's lifetime, five times the numerical values of the radiological worker dose limits in Table 4-1 above.

434 PSE Consent

1. Before a PSE takes place, written consent shall be obtained from each individual involved. Each such written consent shall include the following [see 835.204(d)(1)-(3)]:
   a. the purpose of the planned operations and procedures to be used;
   b. the estimated doses and associated potential risks and specific radiological conditions and other hazards that might be involved in performing the operations; and
   c. instructions on the measures to be taken to keep the dose ALARA considering other risks that may be present.
2. The PSE Consent Form (Appendix 4C, this chapter) shall be used to document the instructions given to an individual. The employee's immediate supervisor and a radiation protection representative (for example, an ESH-1 team leader) shall verbally inform the individual of all items contained on the consent form. Any concerns **s**hall be resolved through counseling from ESH-2, ESH-12, or other organizations.

435 PSE Approvals

1. The PSE shall be approved by the next level safety- and environment-responsible line manager above the requesting manager. The next level of the safety- and environment-responsible line-management chain shall forward the approved PSE request to the Radiation Protection Program manager for review.
2. The Radiation Protection Program manager shall review the PSE for technical content and merit and recommend the PSE, if approved, to the ESH Division director and the requesting organization. The Radiation Protection Program manager shall consider consulting the ALARA Steering Committee on the appropriateness of the PSE.
3. The ESH Division director shall forward the request to the DOE Headquarters program office and the secretarial officer responsible for environment, safety, and health matters for approval [see 835.204(b)].
4. A copy of the written notification of DOE approval shall be provided by the ESH Division director to the Radiation Protection Program manager and requesting organizations.
5. The PSE must be approved as outlined above before the individual is allowed to receive the PSE exposure.

436 PSE Records and Reports

1. The dose from a PSE shall not be considered in controlling the future occupational dose of the individual under the Table 4-1 (above) radiological worker limits, but shall be included in records and reports as specified in chapter 20 [see 835.204(f)]. The ESH-12 Dose Assessment and Radiation Information Management teams shall ensure that this requirement is implemented.
2. Records of the execution of a PSE shall be maintained and a written report submitted to the DOE Headquarters program office and the secretarial officer who is responsible for environment, safety, and health matters within 30 days after the PSE [see 835.204(e)].
3. As specified above, the supervisor or group leader of the individual receiving the exposure shall forward the 30-day report to the Radiation Protection Program manager, the ESH-12 Radiation Information Management team, the next level of Laboratory management, and the DOE Headquarters program office and secretarial officer who is responsible for environment, safety, and health matters The following shall be included in the report:
   a. a copy of the written PSE form, including any cover pages used to forward the form to DOE;
   b. the "as accomplished" information and actual exposures received during the job (obtained from the ESH-12 Radiation Information Management team), entered on the PSE work form;
   c. a copy of the radiation work permit (RWP) (or other work control document) attached to the work form;
   d. an explanation for deviations from the plan;
   e. a copy of the worker's consent;
   f. the ALARA post-job review and actions, entered on the work form;
   g. a copy of the Radiation Protection Program manager's recommendation concerning approval with a copy of the DOE approval; and
   h. the requesting organization shall coordinate sending the 30-day report with the ESH-12 Radiation Information Management team so that they can fulfill the requirement specified in Article 436.3 (above).
4. The ESH-12 Radiation Information Management team shall maintain a file for the PSE that includes everything listed above, the dose assessment from Article 433.1 (above), and the planned exposure data sent to the individual in accordance with Article 436.5 (below).
5. When the Laboratory organization that initiated the PSE reports the results of the PSE to DOE, the ESH-12 Radiation Information Management Team shall also give the individual who received the PSE a report of his or her exposure data. Such a report shall be transmitted no later than the transmittal to DOE [see 835.801(e)]. The ESH-12 Radiation Information Management team shall report PSE data to the individual using the "PSE Report to Individual" form (Appendix 4D of this chapter).

Part 4 Dose Management

To achieve the Laboratory's objective of maintaining individual doses well below regulatory limits, numerical action levels and Laboratory performance goals shall be established below the regulatory limits to administratively control and help reduce individual and collective radiation dose.

441 Action Levels

1. An action level is a notification "flag" that shall be used to notify the worker, the safety- and environment-responsible line-management chain, the ESH-1 team leader, and the Radiation Protection Program manager that the worker has exceeded a predetermined external dose level and is possibly approaching an occupational dose limit. ESH-12 shall issue these notifications electronically after dosimetry data become available.

2. The action levels that shall be applied are shown below:

Dose Being Reported	Notification Action Level
Whole-body dose (EDE)	1 rem (0.01 sievert)
Lens of the eye	3 rem (0.03 sievert)
Extremities/organ/tissue	10 rem (0.1 sievert)
Embryo/fetus	0.1 rem (1 mSv)

3. Upon notification, the safety- and environment-responsible line-management chain and ESH-1 team leader shall review the worker's dose in conjunction with their tasks to identify areas of potential dose savings (ALARA).
4. The safety- and environment-responsible line-management chain shall determine a new notification level and shall communicate this new notification level to the Radiation Protection Program manager and ESH-12. ESH-12 shall notify the individuals specified in Article 441.1 above when this new notification level is reached. **Guidance Note**: The new EDE notification level should not be higher than the 2.0-rem performance goal specified in Article 442 below.
5. When requested, ESH-1 shall provide consultation on efforts to manage doses for workers who are approaching dose limits.

442 Laboratory Performance Goal

1. **Guidance Note**: The Laboratory has set a performance goal (part of Appendix F performance measures) of 2 rem (0.02 sievert) in a year external effective dose equivalent (EDE). This performance goal has been established to ensure that individuals do not exceed the 5-rem (0.05-sievert) TEDE limit. Inherent in controlling doses to below the 5-rem (0.05-sievert) TEDE limit is the expectation that intakes of radioactive material arising from operational incidents are also managed with the ultimate goal of zero intakes.
2. No individual shall be allowed to exceed the Laboratory performance goal without written approval from the Radiation Protection Program manager and the safety- and environment-responsible line-management chain.
3. **Guidance Note**: Organizations required to set annual ALARA goals (refer to Article 324 in chapter 3) may elect to set a maximum individual external dose goal that is lower than the 2 rem (0.02 sievert) annual performance goal set by the Laboratory.

443 Special Control Levels

Guidance Note: Certain situations may require lower individual exposure control levels.

In addition to considering recommendations from line management, the Radiation Protection Program manager shall consider using expertise from other disciplines, such as human resources and legal counsel, in establishing special control levels.

1. A dose management plan shall be established for each radiological worker with a lifetime occupational dose exceeding N rem, where N is the age of the individual in years. The dose management plan shall include a special control level. The special control level shall allow the individual's lifetime occupational dose to approach and, if practicable, fall below N rem during ensuing years as additional occupational dose is received.
2. Employees with special needs, such as those undergoing radiation therapy, shall be considered, and the Radiation Protection Program manager shall establish special control levels.
    2. Special controls on an individual dose shall not be implemented in a manner that interferes with that individual's right to work. If reasonable efforts to implement the special control level below 1 rem (0.01

3. sievert) per year threaten to restrict the individual's right to work or are otherwise unsuccessful, the Radiation Protection Program manager shall consider authorizing any dose in excess of the special control level, but not to exceed the regulatory dose limits.

Appendix 4A
[see 835.2(b), weighting factor]

Weighting Factors for Organs and Tissues

Organs or Tissues	Weighting Factor
Gonads	0.25
Breasts	0.15
Red bone marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30
Whole body	1.00

1. Weighting factors as defined in ICRP Publication 26 and NCRP Report 91 shall be used to convert organ or tissue dose equivalent to effective dose equivalent for the whole body. The effective dose equivalent shall be obtained by multiplying the organ dose by the weighting factor. For example, a 5-rem (0.05-sievert) dose to the thyroid would be multiplied by the weighting factor 0.03 to yield a contribution of 0.15 rem (1.5 mSv) to the total effective dose equivalent.

2. **Guidance Note**: "Remainder" means the five other organs or tissues with the highest dose (for example liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, and upper large intestine). The weighting factor of 0.30 results from 0.06 for each of the five remainder organs [see 835.2(b), weighting factor, note 1].

3. **Guidance Note**: For the case of uniform external irradiation of the whole body, a weighting factor equal to 1 may be used in determining the effective dose equivalent [see 835.2(b), weighting factor, note 2].

Appendix 4B

Planned Special Exposure (PSE) Work Form

(To be completed by the requester in determining the need for a PSE)

Answer all questions below and attach supporting documentation, including a copy of the first page of the RWP.			
	Yes	No	NA
1. Is the proposed task vitally important to the Laboratory's mission?	☐	☐	☐
2. Is there another worker who meets the requirements of this job without the need for a PSE?	☐	☐	☐
3 Is not doing the task a viable alternative?	☐	☐	☐
4. Does an ALARA review indicate the need for a PSE? Contact ESH-12 for assistance in determining (1) if the PSE is necessary and (2) ALARA measures for the PSE if it is undertaken.	☐	☐	☐
5. Is there other decisive information?	☐	☐	☐
Summarize the reasons for request.			

Previous Doses and Dose Limits Section PSE requester identifies the worker and provides the worker's anticipated PSE dose (a. and e.). ESH-12 provides all other dose information.				
Individual's Name:			Z Number	
	TEDE (*rem*)	**Lens of Eye (*rem*)**	**Skin or Extremities (*rem*)**	**Any Organ or Tissue (internal + external) (*rem*)**
a. Anticipated PSE in current year				
b. Previous PSEs in current year				
c. Doses in excess of radiological worker dose limits in current year				
d. Total (a+b+c)				
e. Anticipated PSE in current year				
f. Previous PSEs over worker lifetime (including current year)				
g. Doses in excess of radiological worker dose limits over worker lifetime (including current year)				
h. Total (e + f + g)				
If any of the totals (on line d.) exceed the numerical values of the radiological worker dose limits in Table 4-1 (page 3 of this chapter), the worker is not eligible to receive a PSE. If any of the totals (on line h.) exceed five times the numerical values of the radiological worker dose limits in Table 4-1, the worker is not eligible to receive a PSE.				
This worker is ☐ is not ☐ eligible.				
Signature, ESH-12 Dose Assessment team leader			Date	

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Appendix 4C

PSE Consent Form

1. Purpose of the operation				
2. Specific procedures to be used				
3. ALARA measures to be used (considering other risks that may be present)				
4. Potential risks that may be encountered				
5. Radiological conditions and other hazards that may be encountered (See the RWP and associated maps.)				
6. Your estimated doses from this job are as follows:				
7. When the estimated doses are added to your present doses, you will be exposed to the following doses and risks:				
I have read, asked questions about, and understand the information given above. I give my consent to the planned special exposure (PSE).				
Name (print)		Signature		Z Number
Group Leader or equivalent	Organization	Radiation Protection Representative	Organization	Date

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Appendix 4D

PSE Report to Individual

Name	Z Number

As a result of the planned special exposure (PSE) conducted under RWP or HCP _____ , you received the following doses:

Total effective dose equivalent (TEDE)_____*rem*

Lens of eye dose_____*rem*

Extremities_____*rem*

Skin_____*rem*

Organ or tissue_____*rem*

If you wish to discuss these doses or have any questions, please contact the ESH-12 Dose Assessment team at (phone) _____.

Signature	Date

Date report submitted to worker_____

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Appendix 4E
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Dose Standards	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment in this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information*

   - Radiological workers do not receive more than 5 rem/year (0.05 sievert/year) (TEDE); 15 rem/year (0.15 sievert) to the lens of the eye; 50 rem/year (0.5 sievert/year) (shallow dose equivalent to the skin or any extremity; 50 rem/year (0.5 sievert/year) (CDE and deep dose equivalent) to any organ or tissue other than the lens of the eye; or a lifetime dose equivalent (cumulative TEDE) exceeding their age in rem. (Article 422.1, Table 4-1) Radiological workers whose lifetime dose exceeds their age in rem (for any reason except a planned special exposure or authorized emergency exposure) have a dose management plan to realign their doses with the age limit. (Article 421)
   - Declared pregnant workers receive less than 0.5 rem (5 mSv) from declaration of pregnancy to birth of the child. Substantial variation above a uniform exposure rate that satisfies the 0.5-rem (5-mSv) limit is avoided. Workers who already received greater than 0.5 rem (5 mSv) by declaration are assigned tasks that limit additional exposure to the fetus. (Article 424)
   - Occupational dose limits do not include exposures from background radiation or therapeutic and diagnostic medical radiation. (Table 4-1, Note 3)
   - Planned special exposures (PSEs) are managed and limited as specified in Part 3 of this chapter. Authorized emergency exposures are managed and limited as specified in Chapter 2, Part 3, of this LIR.
   - Off-site occupational exposures are recorded in workers' dose records to ensure compliance with occupational dose limits. (Article 422.1)
   - General employees (nonradiological workers), members of the public, and minors receive less than 0.1-rem/year (1-mSv/year) TEDE from occupational sources. Minors are also limited to 10% of the radiological worker limits for lens of the eye, skin, and extremities. (Article 422.1 and Table 4-1)
   - Workers understand what their dose limits are, what their current doses are, and where to obtain dose reports. (Article 411)

Personnel Dosimetry

Contents

Personnel Dosimetry

Appendix 5A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

511 General Requirements

Who	Shall
Safety- and environment-responsible line-management chain	• Collaborate with the Health Physics Operations Group (ESH-1) and the Radiation Protection Services Group (ESH-12) to ensure that all internal and external personnel dosimetry program elements are implemented and maintained, including resolution of noncooperation issues. • Ensure that personnel are trained and aware of hazards and associated controls related to occupational radiation exposure. • Ensure that personnel do not exceed occupational dose limits. • Assess changes in work activities and work areas to ensure that personnel are monitored as required. • Annually review and approve of routine personnel monitoring status of all workers assigned to the line organization. • Ensure that declared pregnant workers contact Occupational Medicine (ESH-2) and/or ESH-12 for pregnancy and workplace counseling. • Ensure that personnel are aware of radiation dose limits and their own current dosimetry results. **Guidance Note**: Go to http://eshdb.lanl.gov/cgi-bin/esh12/esh12menu.cgi for personal and group dosimetry reports. • Designate an individual in the organization as the dosimetry distribution custodian, and designate a bioassay kit custodian if required. • Ensure that visitors are monitored for radiation. • Notify ESH-1 of any changes to the facility or operation that may affect radiological hazards and work with ESH-1 to update dosimetry matrices to reflect these changes. • Ensure that individuals within span of control (of the safety- and environment-responsible line-management chain) are wearing required external dosimetry and are participating in the in vivo and in vitro bioassay program as required.
Facility managers	Ensure that personnel dosimetry requirements are specified for entry or access to areas posted for radiological hazards (see chapter 9, part 2, for area access requirements).
ESH-1 (in collaboration with the safety- and environment-responsible line-management chain)	• Notify the safety- and environment-responsible line-management chain of any radiological hazards and ensure that all unusual situations or changes involving potential radiation exposures are identified and fully assessed. • Maintain the facility-based dosimetry matrices in collaboration with the ESH-12 Radiological Dose Assessment team, and review the dosimetry matrices annually, at a minimum. • Ensure that dosimetry requirements are incorporated into radiological work permits (RWPs), hazard control plans (HCPs), and other work control documents. • Notify the Radiation Protection Program manager, ESH-2, and ESH-12 as soon as possible after significant potential intakes of radioactive materials, significant non-uniform skin exposures, or significant unexpected external exposure. • Ensure that external dosimeters are returned to the ESH-4 Personnel Dosimetry Operations (PDO) team free of radioactive contamination.

Who	Shall
Health Physics Measurements (ESH-4)	• Provide and maintain all external dosimetry and in vivo monitoring equipment, devices, accreditation programs, technical bases, and technical expertise. • Provide the safety- and environment-responsible line-management chain with lists of thermoluminescent dosimeter (TLD) badges that have not been returned on time, and provide in vivo and in vitro delinquency notifications. • Provide personal nuclear accident dosimeters and accident screening procedures that meet required performance standards. • Promptly provide external dosimetry, in vitro, and in vivo results to ESH-12. • Schedule, track, and pick up all in vitro bioassay kits. • Provide a system to enroll personnel in dosimetry programs that facilitate the use of the facility-based dosimetry matrices. • Develop and maintain the analytical service agreements for analyzing the in vitro bioassay samples.
ESH-12	• Maintain required external and internal radiological dose assessment methods, technical bases, and technical expertise. • Advise ESH-2 medical staff on radiation doses and associated risks. • Establish radionuclide-based monitoring thresholds for internal dosimetry program assignments. • Evaluate pregnancies with respect to radiological work conditions. • Track doses against notification action levels. (See Article 441.2, chapter 4) • Maintain stewardship for all personnel dosimetry records and reporting requirements. • Perform internal and external dose assessments. • When notified that a worker (who is enrolled in a dosimetry program) has undergone an internal medical radionuclide procedure, determine the actions which that worker must take.
ESH-2	Counsel employees in the event of unexpected high radiation doses, intakes of radioactive materials, declared pregnancies, and planned special exposures (PSEs).
Isotope and Nuclear Chemistry (C-INC)	Analyze and report results for in vitro urine and fecal bioassay samples as specified in the ESH/C-INC Analytical Service Agreement. This shall include maintaining kit custody through the analysis process, and developing and maintaining DOE Laboratory Accreditation.

Who	Shall
Workers enrolled in dosimetry programs	• Participate in assigned dosimetry programs according to the requirements of this chapter, including on-time exchange of dosimeters, bioassay sample kits, and keeping in vivo appointments. • Notify immediate supervisor of changes in work assignment or process hazards that could lead to modified dosimetry requirements. • Follow procedures for employee dosimetry enrollment along with supervisor. • Know radiation dose limits and individual current radiation dose. **Guidance Note**: Go to http://eshdb.lanl.gov/cgi-bin/esh12/esh12menu.cgi to access your personal dosimetry data. • Notify immediate supervisor upon approaching action levels and occupational dose limits. • Report lost dosimeters to ESH-1. • Ensure that the whole-body and personal nuclear accident dosimeters are worn on the front of the body between the shoulders and the waist. The whole-body dosimeter must be worn with the circular foil windows facing out and the side labeled THIS SIDE TOWARD CHEST against the chest. The foil windows *must not* be covered while the dosimeter is being worn, unless an RCT instructs otherwise (for example, bagging the dosimeter to prevent contamination). The foil windows are fragile and must be handled carefully. • Ensure that extremity dosimeters are worn on the extremity for which they are intended, as specified in the RWP, HCP, or other work control document. **Guidance Note**: Dosimeters need only be worn in areas or for activities that require them. • Ensure that, when not being worn, the dosimeters are stored where they will not be exposed to temperatures above 100°F, direct sunlight, chemical vapors, physical abuse, or unusual radiation backgrounds. • Ensure that dosimeters issued by Los Alamos National Laboratory are not used at non-Laboratory radiological facilities without approval from ESH-4. • Ensure that participants in either the external or internal dosimetry monitoring programs report to ESH-1 (typically, the area or facility RCT) and the ESH-12 Radiological Dose Assessment team any internal medical radionuclide procedure that has been performed on them, including diagnostic, radio-imaging, and radiotherapy procedures that involve injecting, inhaling, or ingesting radioactive material into the body.

Who	Shall
Dosimetry distribution custodians for TLDs	• Maintain custody control of dosimeters and associated custody-control documentation, including issue and retrieval of dosimeters. • Collect and distribute dosimeters. • Prepare dosimeters for shipment to ESH-4. • Follow up on dosimeters that are not returned by employees. • Provide temporary dosimeters to employees when required. • Provide temporary dosimeters to visitors and subcontractors when required. • Ensure that users complete the temporary badge ID (TBID) card. • Request that visitors return dosimeters at the end of the visit or end of the monitoring period, whichever comes first. • Assist dosimeter users in obtaining and completing lost TLD badge forms. • Ensure that used temporary badges and cards are promptly returned to ESH-4. • Notify immediate supervisor in cases of noncooperation by the dosimetry program participant with regard to returning external dosimetry.
Dosimetry distribution custodians for bioassay kits	• Maintain custody of the bioassay kits. Sign for the transfer of the chain of custody of the bioassay kits. • Distribute bioassay kits to the kit recipients. • Ensure that the kit distribution point is free from any potential contamination. • Assist bioassay kit recipients with questions regarding sample submission. • Notify the immediate supervisor in cases of noncooperation by bioassay kit recipients.
Subcontractor requestors	Notify group or organization administrators when individual subcontractor employees terminate before the default contract termination date.
Group or organization administrators	• Maintain all employee information in the Employee Information System (EIS), including LANL employees, and contractor and subcontractor employees. • Update the default termination date in the EIS with the actual termination date of all contractor and subcontractor employees who terminate before the default contract termination date.

Part 2 Assignment of Dosimetry

521 External Dosimetry

1. Personnel dosimetry shall be provided to and used by individuals as follows:

   a. radiological workers who, under typical conditions, are likely to receive from external sources an effective dose equivalent of 0.1 rem (1 mSv) or more in a year or a dose equivalent to the extremities, lens of the eye, or skin of 10 percent or more of the corresponding limits specified in Table 4-1, chapter 4 [see 835.402(a)(1)];

   b. declared pregnant workers who are likely to receive from external sources a dose equivalent of 0.05 rem (0.5 mSv) or more to the embryo/fetus during the gestation period [see 835.402(a)(2)];

   c. occupationally exposed minors likely to receive from external sources an exposure in excess of 50% of the minor dose limits in Table 4-1, chapter 4 [see 835.402(a)(3)];

d. members of the public who enter an RCA (including RBAs and radiological areas) and are likely to receive an external deep dose equivalent of 0.025 rem (0.25 mSv) or more for one visit [see 835.402(a)(4)]; and

e. individuals entering a High Radiation or Very High Radiation Area [see 835.402(a)(5)].

Guidance Note: As a matter of practice, individual requests for monitoring (external or bioassay) will be honored whether or not they meet these thresholds.

2. Pocket and electronic dosimeters shall be supplemental to the whole-body TLD, providing real-time indication of exposure to radiation and assisting in maintaining personnel doses below administrative dose limits specified in RWPs or other work control documents and are used as follows:

   a. Individuals entering a High Radiation or Very High Radiation Area shall be monitored by a supplemental dosimeter or other means (for example, stay-time tracking) capable of providing an estimate of the individual's deep dose equivalent during the entry (see Article 924, chapter 9, for entry requirements) [see 835.502(a)(2)].

   b. Supplemental dosimetry must also be worn when specified in an RWP, HCP, or other work control document, or when specified by an RCT.

   Guidance Note: The use of electronic dosimeters is encouraged for entry into High Radiation Areas and Very High Radiation Areas or when planned dose equivalents greater than 0.1 rem (1 mSv) in a workday are expected. An electronic dosimeter provides an early warning of unexpected radiation fields using alarm set points at specified dose equivalent rates or integrated dose equivalents.

3. Facilities with enough fissile materials to create a critical mass that would expose individuals excessively in an accident shall ensure that affected individuals are given nuclear accident dosimetry [see 835.1304(a)].

522 Internal Dosimetry

The following individuals shall participate in an internal dosimetry program:

1. Radiological workers who, under typical conditions, are likely to receive a committed effective dose equivalent (CEDE) of 0.1 rem (1 mSv) or more from all radionuclide intakes in a year [see 835.402(c)(1)];

2. Declared pregnant workers likely to receive intakes resulting in a dose equivalent to the embryo/fetus of 0.05 rem (0.5 mSv) or more during the gestation period [see 835.402(c)(2)];

3. Occupationally exposed minors who are likely to receive a CEDE in excess of 0.05 rem (0.5 mSv) from all radionuclide intakes in a year [see 835.402(c)(3)]; and

4. Members of the public who enter an RCA (including RBAs and radiological areas) and are likely to receive an intake resulting in a CEDE exceeding 0.025 rem (0.25 mSv) for the individual visit [see 835.402(c)(4)
Dosimetry Enrollment Process

523 Dosimetry Enrollment Process

Dosimetry enrollment shall be implemented by the process specified in http://eshdb.lanl.gov/~esh12/new_eshdb/des.htm. To complete this process, the employee and supervisor must access the web site and follow the instructions provided.

This process must be repeated annually (that is, an annual review of dosimetry assignment), upon hiring into a new position, upon changing a job assignment that results in a change of dosimetry, upon declaring pregnancy, upon rehiring into a position, and when visiting the Laboratory in areas posted for radiological hazards.

524 Termination of Dosimetry Services

Termination monitoring shall be required of all personnel enrolled in in vivo or in vitro bioassay programs during work at the Laboratory. Additionally, all TLD badges and supplemental external dosimetry must be returned before the individual leaves the Laboratory. The Dosimetry Services Office must be notified at 667-6275 *three days in advance of the termination* to arrange for the termination from these programs.

Part 3 Technical Dosimetry Program Requirements

531 Technical Provisions for External Dosimetry

1. External dosimetry programs shall meet the limit requirements shown in Table 4-1, chapter 4 [see 10 CFR 835.402(b)]. External dosimetry programs implemented to meet the requirements of Article 521.1 (this chapter) shall be

   a. accredited by the DOE Laboratory Accreditation Program (DOELAP) for Personnel Dosimetry [see 835.402(b)(1)];

   b. excepted from accreditation by the DOELAP for Personal Dosimetry [see 835.402(b)(1)]; or

   c. otherwise approved by the assistant secretary for Environment, Safety, and Health [see 835.402(b)(2)].

2. **Guidance Note**: DOE-STD-1095-95 specifies the requirements for accreditation of personnel external dosimetry monitoring programs by the DOELAP for Personal Dosimetry.

532 Technical Provisions for Internal Dosimetry

1. All bioassay programs implemented to demonstrate compliance with Article 522 shall be

   a. accredited by the DOELAP for Bioassay Programs [see 835.402(d)(1)];

   b. excepted from accreditation by the DOELAP for Bioassay Programs [see 835.402(d)(1)]; or

   c. otherwise approved by the assistant secretary for Environment, Safety and Health [see 835.402(d)(2)].

   The requirements for bioassay program accreditation shall be implemented no later than January 1, 2002 [see 835.101(f)].

2. Technical basis documents shall be developed by ESH-12 for the internal dosimetry program. These technical basis documents shall establish requirements and protocols related to routine and special bioassays for radionuclides typically encountered at the Laboratory (specifically for the following):

Pu-238	Pu-239/240	Am-241	H-3	uranium
Be-7	Na-22	Sc- 46	V-48	Cr-51
Mn-54	Co-56	Co-57	Co-58	Co-60
Zn-65	Cu-67	Se-75	Zr-95	Sb-124
Cs-134	Cs-137	Ce-141	Nd-147	Eu-152
Os-185	Tl-201	Tl-202	Hg-203	

   These requirements and protocols shall include baseline bioassays, routine bioassay methods and frequencies, special bioassay triggers (for example, nasal contamination and workplace indicators), and termination bioassay requirements. The safety- and environment-responsible line-management chain shall contact the ESH-1 team leader if work with radionuclides other than those mentioned above is anticipated. ESH-1 shall consult with the ESH-12 Dose Assessment team to determine if a bioassay program is required for work with the radionuclide under consideration.

3. The estimation of internal dose shall be based on bioassay data rather than air concentration values unless one of the following conditions is present [see 835.209(b)]:

   a. bioassay data are unavailable,

   b. bioassay data are inadequate, or

   c. internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.

533 Nuclear Accident Dosimetry

1. The nuclear accident dosimetry system shall include the following:

   a. a method to conduct initial screening of potentially exposed individuals to identify those who have received significant doses [see 835.1304(b)(1)];

   b. equipment and methods that are capable of analyzing biological samples [see 835.1304(b)(2)] and dosimeters;

   c. a system of fixed nuclear accident dosimeter units [see 835.1304(b)(3)] that are capable of measuring the estimated neutron dose and approximate neutron spectrum; and

   d. personnel nuclear accident dosimeters [see 835.1304(b)(4)].

Appendix 5A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Personnel Dosimetry	LIR402-700-01.0

1. The most important criterion for assessing the implementation status in this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment in this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information

   - Individuals who participate in either the external or internal dosimetry monitoring programs report any internal medical radionuclide procedure to the ESH-12 Dose Assessment team. (Article 511)
   - Workers, declared pregnant workers, minors, and members of the public visiting Laboratory property, (refer to Article 521 for monitoring thresholds) and individuals entering High or Very High Radiation Areas are provided and use dosimetry to monitor external exposures. (Article 521)
   - Nuclear accident dosimeters are provided to those individuals who work in facilities with enough fissile materials to create a critical mass with the potential for excessive exposure of individuals in an accident. (Article 521.3)
   - Workers, declared pregnant workers, minors, and members of the public visiting Laboratory property (refer to Article 522 for monitoring thresholds) participate in the in vivo and in vitro bioassay program as required. (Article 522)
   - Supplemental dosimeters or other means of tracking dose (stay-time tracking) are used by individuals entering High or Very High Radiation Areas. (Article 521.2.a).
   - External and internal dosimetry is assigned to workers according to facility-based dosimetry matrices developed for the facility by ESH-1 and maintained by ESH-4. A worker is assigned upon hiring into a new position, upon changing a job assignment that results in a change of dosimetry, upon declaring pregnancy, upon rehiring into a position, and when visiting the Laboratory in areas where exposure is likely. The assignment is also reviewed annually. (Article 523)
   - External dosimeters are worn in accordance with the requirements of Article 531. (Article 531.1)
   - External and internal dosimetry programs are accredited in accordance with the requirements of the DOE LAP. (Articles 532 and 534)

Workplace Monitoring

Contents

Workplace Monitoring

Appendix 6A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

611 General Requirements

Who	Shall
The safety- and environment-responsible line-management chain	• Document hazard analyses according to "Safe Work Practices," LIR300-00-01, or "Hazard Analysis and Control for Facility Work," LIR402-10-01, for all operations and areas under their purview to ensure that Health Physics Operations (ESH-1) can determine radiological monitoring requirements; • Update hazard analyses when changes in work, processes, procedures, configurations, or controls may affect radiological conditions of an operation or area; • Concur with the workplace monitoring and radiological hazard communication established by ESH-1; • Consider making changes to processes, procedures, or controls as required by monitoring program indications, consistent with maintaining exposure to radiological hazards as low as reasonably achievable (ALARA); and • Communicate to ESH-1 (typically, the facility or area radiological control technician, RCT) and his or her safety- and environment-responsible line management chain changes in work, processes, procedures, configurations, or controls that may affect radiological conditions of an operation or area.
Radiological worker	• Communicate to ESH-1 (typically, the facility or area radiological control technician, RCT) and his or her safety- and environment-responsible line management chain changes in work, processes, procedures, configurations, or controls that may affect radiological conditions of an operation or area; • Remain aware of monitoring activities and follow specified, required actions determined by monitoring data, including facility-specific emergency response to alarms; and • Not change monitoring systems unless trained, qualified, and authorized by ESH-1.
ESH-1 (Health Physics Operations)	• Establish workplace monitoring requirements with concurrence of safety- and environment-responsible line-management chain based on radiological hazards analyses; • Perform monitoring tasks; • Communicate monitoring results to workers and the safety- and environment-responsible line management chain; • Evaluate the monitoring program to ensure that it meets established requirements; • Identify changes in workplace radiological conditions and recommend required actions; and • Provide radiological survey and incident data to support evaluation and trending of monitoring program.

Who	Shall
ESH-4 (Health Physics Measurements)	• Provide calibrated instrumentation for monitoring activities; • Provide sample analysis in support of monitoring activities; and • Provide radiological sample analysis and dosimetry data to support evaluation and trending of monitoring program.
ESH-12 (Radiation Protection Services)	Provide radiological dosimetry and incident data to support evaluation and trending of monitoring programs.

Part 2 Requirements

621 General Workplace Monitoring

Workplace monitoring shall provide a basis for posting and labeling, developing radiation work permits (RWPs) and other work control documents, implementing ALARA measures, issuing individual monitoring devices, and verifying the efficacy of design measures and engineering controls.

1. Radiological monitoring of radiation exposure levels, contamination, and airborne radioactivity shall be conducted to
   a. characterize workplace conditions and detect changes in those conditions [see 835.401(a)(2) & (3)];
   b. verify the effectiveness of physical design features and engineering and process controls in containing radioactive material and reducing radiation exposure [see 835.401(a)(5)];
   c. demonstrate regulatory compliance [see 835.401(a)(1)];
   d. detect the gradual buildup of radioactive material in the workplace [see 835.401(a)(4)];
   e. identify and control potential sources of personnel exposure [see 835.401(a)(6)];
   f. determine exposure rates during each entry to a High or Very High Radiation Area [see 835.502(a)(1)]; and
   f. document radiological conditions [see 835.401(a)(2)]
2. The safety- and environment-responsible line-management chain shall use hazard analyses (see Article 611) to determine the potential for radiological hazards in the workplace. These hazard analyses shall be based on the type of radiation generating device or type and quantity of radioactive material being handled, the engineered and administrative controls that have been implemented, the type of operation being conducted, knowledge of historical contamination and radiological work activities, the probability of a change in conditions, and area occupancy factors. This hazard analysis shall be communicated to ESH-1 via an activity hazard analysis (AHA), hazard control plan (HCP), or other documented hazard analysis.
3. ESH-1 shall perform assessments of areas and operations based on hazard analysis input from line organizations. Based on these assessments, ESH-1 shall recommend monitoring survey frequencies. The safety- and environment-responsible line-management chain responsible for the areas and operations shall concur with these survey frequencies, based on their understanding of associated radiological hazards.
   Guidance Note: The survey frequencies may be modified according to changes in hazard analysis results and trends with agreement between ESH-1 and the safety- and environment-responsible line-management chain.

4. All personnel performing monitoring shall be trained and qualified under the standard Laboratory radiation protection program administered by ES&H Training (ESH-13) [see 835.103] or shall be authorized by ESH-1 to perform such monitoring. The monitoring instruments used shall be [see 835.401(b)]

   a. periodically maintained and calibrated by ESH-4;

   b. suitable for the types, levels, and energies of radiation to be detected;

   c. those required for existing environmental conditions; and

   d. routinely tested for operability in accordance with ESH-1 instrument procedures.

5. ESH-1 shall routinely (as specified in ESH-1 documents) review the workplace monitoring program for effectiveness and whenever facility or operational changes are made that may affect radiological control.

6. Monitoring conducted by ESH-1 shall validate area designations based on monitoring results and the requirements of chapter 14 and chapter 15 (Attachments N and O) of this LIR.

7. When work has the potential for causing significant changes in levels of radiation, surface contamination, or airborne activity, monitoring shall be performed before, during, and after the work, consistent with maintaining the dose ALARA.

8. Results of surveys shall be readily available, documented [see 835.401(a)(2)], and, if hazards change significantly, communicated to personnel to inform them of radiological conditions.

9. Area monitoring data shall be compiled and reviewed periodically (as specified in ESH-1 documents) to determine trends (for example, gradual buildup of radioactive material). The safety- and environment-responsible line-management chain shall take action to counter adverse trends.

622 Radiation Exposure Monitoring

1. High Radiation Areas and Very High Radiation Areas shall be monitored for external dose rates by ESH-1 before each entry by workers [see 835.502(a)(1)]. The safety- and environment-responsible line-management chain responsible for the area to be accessed (or the workers accessing the area) shall notify ESH-1 before the entry. ESH-1 shall perform the monitoring of the area at the request of the safety- and environment-responsible line-management chain.

2. Article 1725, chapter 17, shall be referred to for requirements regarding dose rate surveys for radioactive materials received from transportation.

623 Contamination Monitoring

1. Chapter 14, part 3, of this LIR shall be referred to for requirements and guidance for material release surveys.

2. Article 1725, chapter 17, shall be referred to for requirements regarding contamination surveys for radioactive materials received from transportation.

3. Contamination surveys shall incorporate techniques to detect both removable and fixed contamination except as specified in note 2, paragraph 2, of Table 14-1, chapter 14.

624 Airborne Radioactivity Monitoring

Air monitoring programs shall be established to ensure that airborne radioactivity is monitored at a frequency that is consistent with the hazards of the activities planned for the area. Air-monitoring equipment shall be selected according to the specific job being monitored. **Guidance Note**: This equipment may include portable and fixed air sampling equipment and/or continuous air monitors.

1. Air sampling equipment shall be used where an individual is likely to receive an annual exposure of 40 or more derived air concentration (DAC) hours [see 835.403(a)(1)]. **Guidance Note**: This intake generally represents a committed effective dose equivalent (CEDE) to an individual of approximately 0.1 rem (1 mSv).

2. Samples shall be taken as required to characterize the hazard in areas where respiratory protection devices have been prescribed for protection against airborne radionuclides [see 835.403(a)(2)].

3. Real-time (or continuous) air monitors shall be used to provide early warning to individuals of events that could lead to substantial unplanned exposures to airborne radioactivity. **Guidance Note**: Such exposures could result from a breakdown of engineered controls or improper establishment of boundaries during work that creates airborne radioactivity.

4. Real-time air monitoring shall be used to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material [see 835.403(b)]. These real-time air monitors shall have alarm capability and enough sensitivity to alert potentially exposed individuals that immediate action is required to minimize or terminate inhalation exposures.

5. Air monitoring equipment shall be calibrated and maintained at least once each year [see 835.401(b)]. ESH-4 shall calibrate and maintain the radiation detection portions of this equipment. The Measurements Technology Group in the Engineering Sciences and Applications Division (Standards and Calibration Laboratory) and the support service subcontractor shall calibrate and maintain the pump and air-flow- and volume-measuring portions of this equipment, respectively.

Appendix 6A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Workplace Monitoring	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.
2. The recommended major implementation criteria for self-assessment in this chapter are the following.
   Note: The article number is given with each bullet to help the reader find more information.

   - The types of surveys and their frequencies are based on hazard analyses for the area or operation. (Article 621.3)
   - Surveys are performed by trained and qualified individuals. (Article 621.4)
   - Area monitoring data trends are noted and actions are taken by the safety- and environment-responsible line-management chain to counter adverse trends. (Article 621.9)
   - Contamination surveys are performed to detect both removable and fixed contamination. (Article 623.3)
   - Air sampling is performed where individuals are likely to receive ≥40 DAC-hours per year as well as in areas where respiratory protection is prescribed for protection against airborne radionuclides. (Article 624.1)
   - Continuous air monitors are provided in areas where events could lead to substantial unplanned exposures to airborne radioactivity. (Article 624.3)
   - Air monitoring equipment is calibrated and maintained at least once per year. (Article 624.5)

Area Designations and Posting

Contents

Area Designations and Posting

Appendix 7B of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

711 General Requirements

Who	Shall
The safety- and environment-responsible line-management chain	• Ensure that radiological postings and area designations are implemented in accordance with the requirements of this chapter and the concurrence of Health Physics Operations (ESH-1). • Review new and proposed radiological sign modifications before modifications are submitted to the Laboratory Sign Standards Committee. • Communicate any operational changes to ESH-1 that may affect area designations and postings.
Radiological workers	• Read and obey all postings. • Report faded or illegible postings to ESH-1. • Communicate any operational changes that may affect area designations and postings to ESH-1.
Health Physics Operations (ESH-1) team leaders	• Assist in implementing this chapter of the LIR. • Ensure that required materials are available for posting. • Periodically review the radiological posting.
Sign Standards Committee	Approve operations-related signs, labels, and tags used at the Laboratory.
ESH-1 radiological control technicians (RCTs)	• Advise operations personnel of significant changes in radiological conditions that require posting changes, • Post areas in accordance with the requirements of this chapter, and • Maintain legibility of posting and labeling.

Part 2 Requirements

721 General Posting Provisions

1. Radiological postings (signs, labels, and tags) shall be affixed to warn individuals to the presence of radiation and radioactive materials and to aid them in controlling exposures and preventing the spread of contamination.

2. Postings shall depict the standard radiation symbol (radiation warning trefoil), colored magenta or black on a yellow background [see 835.601(a)]. The wording on the posting shall be either magenta or black. Postings and radiation symbols shall be consistent with industry radiation protection standards and requirements promulgated by LIR402-100-01, "Signs, Labels, and Tags," and shall not conflict with local security requirements [see 835.602(b)]. Radiological signs shall be posted by ESH-1 RCTs or other personnel authorized by ESH-1.

3. Signs shall be conspicuously posted at each access point to areas with radiological hazards [see 835.601, 603]. Signs shall be clearly worded and where required shall include any supplemental information to clearly identify and communicate the nature of the hazards and established controls, including entry requirements [see 835.601(b)]. For multiple access points, the entry requirements on each sign shall be the same. Boundaries shall also be posted, commensurate with the risk. Signs used for training shall clearly read FOR TRAINING PURPOSES ONLY.

4. Each sign shall be divided into three sections. The top section shall inform the worker of the type of area (such as Radiological Controlled Area, Contamination Area, or Radiation Area). The middle section shall inform the worker about the type and level of radiation that may be encountered. The bottom section shall contain information specific to the facility or radiological area, such as training, protective clothing, and dosimetry requirements.
5. Postings shall be maintained in a legible condition and shall be updated according to the results of the most recent surveys and/or knowledge of the radiological operations and conditions.
6. If more than one radiological condition (such as contamination and high radiation) is present in the same area or if designated areas have adjoining boundaries, each condition shall be identified [see 835.603].
7. In areas where work is ongoing, the dose rate and contamination level or range of each shall be included on, or in conjunction with, each posting.
8. A sign stating the exit requirements shall be posted at each exit from a posted area. If such signs are not used, an RCT must be available to communicate exit requirements.
9. **Guidance Note**: Posting and labeling requirements may be modified for Laboratory activities conducted on property outside the Laboratory (that is, private residences or businesses).
10. The modifications referred to in the guidance note above shall provide the same level of protection as the provisions specified in this article. [see 835.601(c)]
11. Physical barriers shall be set up so that they do not impede emergency exits or evacuation routes [see 835.501(e), 502(d)].
12. Areas shall be clearly and conspicuously posted [see 835.601(b)]. Signs shall not be hidden or obscured by open or closed doors, equipment, signs, clothing, or other objects.
13. A radiological posting that signifies the presence of an intermittent radiological condition shall include a statement specifying when the radiation is present, such as WHEN MACHINE IS OPERATING or WHEN RED LIGHT IS ON.
14. Variances or exceptions to the radiological area posting requirements shall be made for accessible areas only in the following situations:
    a. During transient radiological conditions of less than eight continuous hours, when radiological area posting is not practical, such as during radioactive material transfers. Under these conditions, the area shall be continuously observed and controlled by individuals who are knowledgeable of and empowered to implement required access and exposure control measures [see 835.604(a)]. These individuals must be stationed where they can provide direct, line-of-sight surveillance and can give verbal warnings. **Guidance Note**: The HOT JOB EXCLUSION AREA (HJEA) sign is recommended for use in these situations.
    b. When the area contains only packages of radioactive material—labeled and in nondegraded condition—received from radioactive material transport while awaiting survey in accordance with Article 1725, chapter 17 [see 835.604(c)].
15. The exceptions discussed above shall apply only to radiological area and radioactive material area posting requirements and shall not apply to the entry control requirements established in chapter 9 and the training requirements of chapter 8 of this LIR.
16. Radiological workers shall communicate to ESH-1 personnel operational changes that may affect the posting of an area.
17. Altering standardized wording on a permanent sign changes the status of the sign from permanent to temporary and must be approved by the safety- and environment-responsible line-management chain and ESH-1 supervision. These temporary signs shall only be used up to three months in accordance with section 6.4 of LIR402-100-01, “Signs, Labels, and Tags.”
18. **Guidance Note**: Refer to Appendix 7A for an explanation of radiological posting conventions.

722 Posting Radiological Controlled Areas (RCAs)

Guidance Note: RCAs are established and posted to warn individuals that they are entering areas controlled for radiation protection purposes. All radiological areas lie within the boundaries of RCAs. Individuals who enter only the RCA without entering radiological areas or Radioactive Materials Areas (RMAs) are not expected to receive a total effective dose equivalent (TEDE) exceeding 0.1 rem (0.001 sievert) in a year [see 835.602(a)].

1. Each access point to an RCA shall be posted as specified in Article 722.2 below whenever radiological areas are present in the RCA [see 835.602(a)].
2. RCAs shall be posted with the words NOTICE, CONTROLLED AREA, ACCESS CONTROLLED FOR RADIOLOGICAL PURPOSES.
3. The following criteria shall be used for designating RCAs.

Designation	Criteria
RCA for external radiation	Access to the area is managed to protect individuals from exposure to radiation. *Note: For areas where the potential exists for both removable contamination and external exposure, posting must include both designations.*
RCA for contamination	The potential for the presence of removable contamination at levels of those specified in Table 14-1, chapter 14, is low. *Note: Depleted uranium (DU) shrapnel from explosive testing shall be managed as an "RCA for DU shrapnel."*
RCA for DU shrapnel	DU exists as a result of explosive testing. Refer to Article 1424.4 for DU shrapnel control requirements.
RCA for volume contamination	Volume-contaminated materials that are not individually labeled may be present.

723 Posting Radiological Buffer Areas (RBAs)

Guidance Note: RBAs are intended to provide secondary boundaries within the RCA to minimize the spread of contamination and to limit doses to general employees who have not been trained as radiological workers. RBAs are considered part of the RCA. However, RBAs are considered to be an area of relatively higher radiological risk, where individuals are likely to receive greater than 0.1 rem (0.001 sievert) external dose in a year and/or where a higher potential is present for contamination levels that are above Table 14-1, chapter 14, levels. RBAs may also be used for laboratories containing hoods or glove boxes and rooms containing radiation-producing machines.

1. **Guidance Note**: An RBA should be established for contamination control as a secondary boundary around Contamination, High Contamination, and Airborne Radioactivity Areas. The size of the RBA should be commensurate with the potential for the spread of contamination.
2. **Guidance Note**: An RBA should be established as a secondary boundary around Radiation, High Radiation, and Very High Radiation Areas where the expected dose to individuals routinely accessing the areas immediately adjacent to these radiological areas would be greater than 0.1 rem (0.001 sievert) per year.

3. An RBA shall not be required in the following areas or situations:
   a. High Contamination or Airborne Radioactivity Areas that are completely within contamination areas;
   b. Inactive Contamination, High Contamination, or Airborne Radioactivity Areas (that is, areas to which entry has been prohibited by posting or barricades);
   c. exposure control, if other posted boundaries or controls provide equivalent employee protection; or
   d. exposure control, if general employees who are not trained as radiological workers are restricted from unescorted entry to RCAs.
4. **Guidance Note**: The need for RBAs around radioactive material areas, soil contamination areas, and underground radioactive material areas should be evaluated according to the potential for exposure of unmonitored individuals and the spread of contamination.
5. Posting of RBAs shall contain the wording CAUTION, RADIOLOGICAL BUFFER AREA and any other information required for hazard communications.

724 Posting Radiation Areas

1. Areas shall be posted to alert individuals to the presence of external radiation in accordance with Table 7-1 below [see 835.601, 603].
2. Radiation Areas and High Radiation Areas shall be identified according to the dose equivalent rates at a distance of 30 centimeters either from the source or from any surface penetrated by the radiation [see 835.2(a), Radiation Area and High Radiation Area]. Very High Radiation Areas shall be identified according to the dose rate at a distance of 100 centimeters (1 meter) either from the source or from any surface penetrated by the radiation [see 835.2(a), Very High Radiation Area].
3. **Guidance Note**: Dose received in an hour may be used as a criterion for posting (column 2 of Table 7-1 below). It would apply to machine-produced radiation fields where a duty factor is present.

   High doses received at high dose rates (such as doses received in a very high radiation area) shall be measured and recorded in units of "rads" rather than "rem" in an hour.

Table 7-1. Criteria for Posting Radiation Areas

Area	Criteria	Required Posting
Radiation Area	> 0.005 rem (0.05 mSv) in 1 hour at 30 cm	CAUTION, RADIATION AREA [see 835.603(a)]
High Radiation Area	> 0.1 rem (1 mSv) in 1 hour at 30 cm	CAUTION or DANGER, HIGH RADIATION AREA [see 835.603(b)]
Very High Radiation Area	> 500 rads (5 grays) in 1 hour at 100 cm	GRAVE DANGER, VERY HIGH RADIATION AREA [see 835.603(c)]

725 Posting Contamination, High Contamination, and Airborne Radioactivity Areas

1. Areas shall be posted to alert individuals to the presence (or likely presence) of surface contamination and airborne radioactivity in accordance with Table 7-2 below [see 835.603].
2. Derived air concentration (DAC) values found in 10 CFR 835 (Appendixes A and C of the rule) shall be used in posting airborne radioactivity areas in accordance with Table 7-2 below [see 835.209(a)].

Table 7-2 Criteria for Posting Contamination, High Contamination, and Airborne Radioactivity Areas

Area	Criteria	Required Posting
Contamination Area	Removable contamination levels (dpm/100 cm^2) that are greater than (or likely to exceed) Table 14-1 values but do not exceed 100 × Table 14-1 values[a]	CAUTION, CONTAMINATION AREA [see 835.603(e)]
High Contamination Area	Removable contamination levels (dpm/100 cm^2) that are greater than (or likely to exceed) 100 × Table 14-1 values[a]	CAUTION or DANGER, HIGH CONTAMINATION AREA [see 835.603(f)]
Airborne Radioactivity Area	Airborne concentrations (µCi/ml) above background that are greater than (or likely to exceed) the DAC values or that would result in an individual (without respirator) being exposed to greater than 12 DAC-hrs in a week (see Glossary, Attachment U)	CAUTION or DANGER, AIRBORNE RADIOACTIVITY AREA [see 835.603(d)]

[a] An area shall be considered a Contamination Area or High Contamination Area if as least 10% of the smears taken in the area exceed the applicable limit.

726 Posting Radioactive Material Areas

1. Accessible areas where items or containers of radioactive material in quantities exceeding the values shown in Appendix 16A, chapter 16, are used, handled, or stored shall be posted CAUTION, RADIOACTIVE MATERIAL(S) [see 835.603(g)].
2. **Guidance Note**: Radioactive material areas may be located outside Radiological Controlled Areas.
3. Variances or exceptions to the posting requirements shall be made for Radioactive Material Areas only in the following situations:
   a. The area is posted as a radiological area in accordance with Article 724 or 725 in this chapter [see 835.604(b)(1)];
   b. Each item or container of radioactive material in the area is clearly labeled to warn individuals of the hazards [see 835.604(b)(2)]. **Guidance Note**: The radioactive material labeling exceptions listed in Table 17-2, chapter 17, may also be invoked in this situation.
   c. The radioactive material of concern consists solely of structures or installed components that have been activated (that is, by being exposed to neutron radiation or particles produced by an accelerator) [see 835.604(b)(3)].
   d. The area contains only packages of radioactive material—labeled and in nondegraded condition—received from radioactive material transport while awaiting monitoring in accordance with Article 1725 [see 835.604(c)]; or
   e. For periods of eight continuous hours or less, the area is under the direct observation and control of an individual who is knowledgeable of, and empowered to implement, required access and exposure control measures [see 835.604(a)]. This individual must be stationed where he or she can provide direct, line-of-site surveillance and can give verbal warnings.
4. Other requirements for labeling radioactive material shall be as specified in chapter 17.

727 Posting Soil Contamination Areas

1. **Guidance Note**: Soil contamination areas may be located outside RCAs if exposure to the material in the area is not likely to cause any individual to receive a TEDE in excess of 0.1 rem (0.001 sievert) in a year.

2. If the contamination levels in a soil contamination area exceed the values shown in Table 14-1, chapter 14 (as evidenced by the likelihood of tracking contamination out of the area at levels exceeding these values), then the area is a Contamination Area or High Contamination Area and shall be posted in accordance with Article 725, this chapter [see 835.2(a), Contamination Area and High Contamination Area and 835.603(d) and (e)].

728 Additional Posting Requirements

1. Once it has been established that an area is likely to exceed or has exceeded the levels requiring posting as a radiological area for contamination or airborne radioactivity, either the area must be posted as a radiological area or the eight-hour posting exception in accordance with Article 721.14.a, this chapter, must be invoked. The HOT JOB EXCLUSION AREA (HJEA) sign alone shall not be used.

   Guidance Note: However, the HJEA sign may be used in conjunction with other radiological area postings as a warning to ensure that unauthorized workers do not enter the posted area. This sign may also be used for extended periods of time when conditions do not exist that would require the area to be posted as a radiological area.

   The HJEA sign shall be used only in conjunction with a radiation work permit (RWP) or hazard control plan (HCP), which specifies its use, including entry and exit requirements for the area being posted.

2. Equipment with known or potential internal contamination such as glove boxes, open-front hoods, piping, sealed ventilation systems, and pumps shall be posted with the radioactive material sign or label containing the standard radiation warning trefoil and the words CAUTION, RADIOACTIVE MATERIAL. An INTERNAL CONTAMINATION or POTENTIAL INTERNAL CONTAMINATION comment and a requirement for RCT coverage for any work done on the system shall be specified at the bottom of the sign. In some cases, entire laboratories or facilities are filled with such contained systems; thus, if this posting is not used on the individual pieces of equipment, then the following conditions shall apply:

   a. Each room must be posted with a sign designating the radiological hazards;

   b. Written requirements shall be established by the facility manager or the safety- and environment-responsible line-management chain responsible for the system(s) to require RCT coverage when such systems are compromised; and

   c. Once an item has been removed from such a system, it shall be identified as radioactive material in accordance with Articles 1721 and 1722, chapter 17.

Appendix 7A

Radiological Posting Conventions

Term	Threshold Value (likelihood of event occurring per year)	Event	Area Designation
Incredible	1E-06	N/A	N/A
Credible	> 1E-06		
Reasonable Potential—Unlikely	0.5	Individual receives < 100 mrem/yr, or Removable surface contamination levels > Table 14-1	RCA
Reasonable Potential—Likely	> 0.5	Individual receives > 100 mrem/yr, or Removable surface contamination levels > Table 14-1	RBA
Actual	1.0	Removable surface contamination levels > Table 14-1	Contamination Area or High Contamination Area (100 × Table 14-1 values)

Appendix 7B
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Area Designations and Posting	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.
2. The major recommended implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information*

   - Radiological signs are conspicuously posted at access points, are clearly worded, and where appropriate, include supplemental information to clearly identify and communicate the nature of hazards and established controls, including entry requirements. (Article 721.3)
   - Posted radiological signs are appropriate for the radiological conditions in the area. (Articles 721.6, 722, 723, 724, and 725)
   - Radiological signs are legible. (Article 721.5)
   - HJEA signs are used in conjunction with an RWP or HCP that specifies entry and exit requirements for the HJEA. (Article 728.1)
   - Accessible areas where radioactive items or containers of radioactive material in excess of the quantities specified in Appendix 16A are posted as Radioactive Material Areas except as otherwise noted in this chapter. (Article 726)

Radiological Training and Qualification

Contents

Radiological Training and Qualification

Appendix 8B in this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

811 General Requirements

Who	Shall
Group leaders or equivalent	• Assign training plans to individuals. • Annually review these training plans and make changes when required.
The designated training generalist (DTG)	• Coordinate with the group leader and ES&H Training (ESH-13) to assign training plans. • Make training materials available to individuals.
Individuals	Obtain self-study-training materials from the DTG or on line at http://www.lanl.gov/internal/training/training.html. • Schedule classes and/or tests through the DTG or ESH-13. • Complete the assigned training.
ESH-13	• Develop and deliver Laboratory-wide radiation protection training. • Maintain Laboratory-wide radiation protection training records in the Employee Development System (EDS).

812 Purpose

This chapter establishes requirements that shall be implemented to ensure that individuals have the training to work safely in and around radiological hazards and to maintain their individual radiation exposure and the radiation exposures of others *as low as reasonably achievable* (ALARA). Training requirements in this chapter shall apply to individuals who are entering areas at the Laboratory that have radiological hazards and to other individuals who are responsible for developing and implementing radiological control measures.

813 Standardization

10 CFR 835.901 establishes radiation safety training program requirements that shall be implemented for two classes of individuals: (1) those who are permitted unescorted access to Radiological Controlled Areas (RCAs) or who are occupationally exposed to radiation and (2) those who are permitted unescorted access to radiological areas or who perform unescorted assignments as a radiological worker. These training programs shall be referred to as general employee radiological training (GERT) and radiological worker (RW) training, respectively. In addition, 10 CFR 835.103 establishes requirements that shall be implemented for the education, training, and skills of individuals who are responsible for developing and implementing measures necessary for ensuring compliance with 10 CFR 835.

a. Training programs for members of the public, for general employees, and for radiological workers shall be consistent with parts 2 and 3 of this chapter. Additional training programs consistent with those discussed in parts 4 and 5 of this chapter shall be required to ensure implementation of the education, training, and skills requirements of 10 CFR 835.103. **Guidance Note**: Affected individuals may include the safety- and environment-responsible line-management chain, supervisors, technical specialists, researchers, radiological control technicians (RCTs), clerks, and engineers.

b. The purpose of this training shall be to provide and assess worker knowledge, skills, and abilities with the specific objective of enabling the worker to perform jobs safely and adhere to required radiation protection practices. Subject matter that is required for safe job performance shall be emphasized rather than general knowledge of physical principles.

814 General Provisions

1. Radiation safety training shall include the following topics, depending on each individual's previous training, work assignments, and degree of exposure to potential radiological hazards:

   a. risks of exposure to radiation and radioactive materials, including prenatal radiation exposure [see 835.901(c)(1)];

   b. basic radiological fundamentals and radiation protection concepts [see 835.901(c)(2)];

   c. controls, limits, policies, procedures, alarms, and other measures implemented at the facility to control doses and contamination ALARA, including both routine and emergency actions [see 835.901(c)(3)];

   d. individual rights and responsibilities in implementing the facility radiation protection program [see 835.901(c)(4)];

   e. individual responsibilities for implementing ALARA measures [see 835.901(c)(5)]; and

   f. individual exposure reports that may be requested [see 835.901(c)(6)].

   This information shall be communicated in facility orientations and/or in site and facility radiological training according to the level of training required for the hazards that might be present.

2. Group leaders or equivalent, with the assistance of ESH-13 and the DTG, shall identify the required level of radiological training for each individual and document it in a training plan.

3. At a minimum (see Appendix 8A), all unescorted workers (including visitors who are considered general employees as defined by the DOE) who enter RCAs, Radioactive Material Areas (RMAs) and Underground Radioactive Material Areas (URMAs) shall receive GERT. Alternatives that shall apply to visitors who are members of the public are discussed in Article 822 of this chapter.

4. Before an individual is permitted to enter a radiological area unescorted or to perform unescorted radiological work, he or she shall have completed training commensurate with the hazard in the area and the required controls [see 835.901(b)]. Appendix 8A of this chapter specifies the level of training that shall be required for each defined area. Examinations shall be used to demonstrate satisfactory completion of RW training [see 835.901(b)]. Examinations shall be written; however, the Radiation Protection Program manager and ESH-13 shall have the authority to approve alternatives to accommodate special needs.

5. Facility- and operations-specific orientations and training shall provide knowledge of facility requirements, job-specific knowledge, skills, and abilities required for the specific job duties of workers and the radiological hazards present in the facility, area, or operation.

6. GERT and RW retraining shall be completed at intervals not to exceed 24 months [see 835.901(e)]. **Guidance Note**: The 24-month retraining frequency may be extended by 30 days to accommodate scheduling conflicts [see 835.3(e)].

   Changes to the radiological control program shall be incorporated as they are identified and a decision made if training is needed before the 24-month period [see 835.901(e)].

   Note: The RW practicum shall be required only for initial training unless required biennially by specific Laboratory facilities or the safety- and environment-responsible line-management chain.

7. Unsupervised assignments shall be preceded by initial training (and examination for RW training). In special cases in which a worker must enter an area (see Appendix 8A) before the completion of training, training may be given concurrently with the assignment if the worker is being escorted in accordance with Articles 821.2 and 831.4 of this chapter.

8. ESH-13 shall develop and maintain Laboratory-wide ES&H training plans and courses, and make these available as required.

9. The training plans assigned to individuals by their group leader or equivalent shall identify the biennial refresher training required to maintain qualifications. **Guidance Note**: Refresher training does not have to

repeat the initial training, and may be hazard-specific.

Training plans shall be reviewed and updated annually by the group leader or equivalent, based on the radiological hazards to which the individual will be exposed.

10. The EDS database shall identify individuals whose training plans are complete, incomplete, or expired. The group leader or equivalent, with the assistance of ESH-13 and the DTGs, shall monitor this database or an equivalent system and shall restrict the activities of individuals whose assigned training plans are incomplete or expired.

11. Training shall be recorded in the EDS. Training rosters, including the name, Z number, and signature of each individual, shall be sent to EDS Entry, ESH-13, MS J596. ESH-13 shall also issue certification cards to workers who have completed the DOE standardized RW qualification.

12. Requirements for training records and course documentation are explained in Article 2024, chapter 20.

Part 2 General Employee Radiological Training (GERT)

821 Site Personnel

1. Individuals shall complete radiation safety training before they are given unescorted access to RCAs or to RMAs and URMAs, where they are not likely to receive greater than 0.1 rem (0.001 sievert) in a year, and before receiving occupational radiation exposure during access to Radiological Controlled Areas (whether escorted or not) (refer to Appendix 8A) [see 835.901(a)]. This training shall address the radiation safety training topics in Article 814.1 of this chapter according to the degree of exposure to radiological hazards that may be encountered and the required controls [see 835.901(a)].

2. Untrained individuals who are expected to receive occupational radiation exposure during access to RCAs under escort shall receive, at a minimum, training covering the topics listed in Article 814.1. a. and f of this chapter.

3. If an escort is used in lieu of training, the escort shall have completed the level of training required for the areas to be entered and the work to be performed (including examinations and performance demonstrations) and shall ensure that the escorted individual implements the requirements of the facility's or organization's radiation protection program [see 835.901(d)].

822 Radiological Orientation for Members of the Public

1. Refer to Article 821.3 for escort requirements for members of the public. Refer to Article 926 for member-of-the-public entry requirements.

2. In the unlikely event that members of the public are given unescorted access to RCAs, they shall receive radiation safety training before they enter the RCAs [see 835.901(a)(1)]. This training shall address the radiation safety training topics in Article 814.1 of this chapter according to the degree of exposure to radiological hazards that may be encountered and the required controls [see 835.901(c)].

3. Escorted or unescorted members of the public who are expected to receive occupational radiation exposure during access to RCAs shall receive, at a minimum, training covering the topics listed in Article 814.1.a. and f.

Part 3 Radiological Worker (RW) Training

Appendix 8A of this chapter summarizes the requirements that shall be implemented for those individuals who must receive RW training.

831 General Provisions

1. Each individual shall demonstrate knowledge of the radiation safety training topics established in Article 814.1 of this chapter, commensurate with the hazards in the area and required controls, by successfully completing a written examination and practicum (initial training only, unless otherwise required by the facility or the safety- and environment-responsible line-management chain) before they are permitted unescorted access to Radiological Buffer Areas (RBAs) and radiological areas, before they perform unescorted assignments as radiological workers, and as otherwise noted in Appendix 8A of this chapter [see 835.901(b)].
2. RW training shall satisfy the requirements of GERT (see Part 2 of this chapter).
3. RW training must prepare the worker to deal with radioactive contamination as well as external radiation hazards. **Guidance Note**: RW-I training will no longer be offered as a separate course. Current RW-I-qualified individuals may continue as RW-I individuals in their training plans.

   To requalify, RW-I individuals must challenge a written RW examination that includes contamination control questions. **Guidance Note**: In addition, the RW-I-qualified individual may become RW-qualified by successfully challenging the RW practicum, which includes contamination control scenarios.
4. If an escort is used in lieu of training, the escort must have completed the level of training required for the areas to be entered and the work to be performed and must ensure that the escorted individual implements the requirements of the radiation protection program [see 835.901(e)].
5. Standardized RW training that has been received at another DOE site or facility within the past two years must be supplemented with Laboratory site-specific training and accepted as the equivalent of Laboratory RW training.

832 X-Ray Safety Training

1. X-ray safety training shall be specifically approved in place of RW training for the following low-hazard (class I) x-ray devices:
   a. cabinet x-ray systems as defined in 10 CFR 1020.40,
   b. enclosed beam analytical x-ray systems as defined in ANSI 43.2,
   c. exempt shielded and unattended x-ray devices as defined in ANSI 43.3, and
   d. x-ray devices that do not have a reasonable potential of exposing an individual to more than 0.1 rem (1 mSv) per year.
2. Operators of open beam, open installation, and shielded x-ray devices (classes II and III) shall be required to successfully complete both x-ray safety training and RW training.

833 Emergency Response Personnel

1. Any individual who may be assigned to perform emergency actions that could result in a dose exceeding the occupational dose limits shall successfully complete RW or the combination of Emergency Responder Radiological Training (course number 15664) and the Emergency Responder Radiological Training Drill (course number 17793) [see 835.1302(c)]. This training shall be successfully completed at two-year intervals (for example, requalification or test-out for RW).
2. Before assigning an individual to perform emergency actions likely to result in occupational doses exceeding the radiological worker dose limits in Table 4-1, chapter 4, the on-scene incident commander shall ensure that these individuals have successfully completed the training described above.

Part 4 RCT Training and Qualification

841 Requirements

Training and qualification of RCTs and their immediate technician supervisors shall address routine operations and also focus on recognizing and handling situations in both normal and changing radiological conditions. Newly qualified technicians and technicians still in training shall be given the opportunity to work with qualified, experienced technicians to foster development. Core training for RCTs shall be provided by ESH-13. The comprehensive written examination for qualification and requalification shall be administered by ESH-13.

842 RCT Training and Qualification

1. RCT qualification shall consist of the standardized core training material, on-the-job training according to the qualification requirements, and passing both a final comprehensive written examination and final oral examination board.
2. RCT training shall use the standardized core training materials and shall emphasize Laboratory-specific information.
3. **Guidance Note**: RCT candidates who have prerequisite knowledge, such as college credit, operational experience, or related qualifications, may satisfy individual sections of the standardized core training requirements by passing challenge examinations.
4. Entry-level prerequisites shall be established to ensure that RCTs meet requirements for physical condition and education. **Guidance Note**: At a minimum, these requirements should include the following:
    a. high school education or equivalent;
    b. fundamentals of mathematics, physics, and chemistry;
    c. reading and comprehension level sufficient to follow procedures, write permits, prepare survey maps, write reports, and prepare shipping and transfer permits;
    d. ability to work in a support role and to communicate verbal instructions to others; and
    e. the physical requirements for handling personal protective equipment and other kinds of equipment, and assisting others in work locations, commensurate with the assignment.
5. **Guidance Note**: RCTs are encouraged to pursue registration by the National Registry of Radiation Protection Technologists (NRRPT).
6. The Laboratory shall provide credit toward completion of core training requirements for the NRRPT registration when requested by the employee.

843 Continued Training

1. Following successful completion of standard core training requirements, including practical (on-the-job) training, the RCT shall pass both a comprehensive written examination and an oral examination board for final qualification.
2. Following the initial oral examination board qualification, the RCT shall begin a two-year cycle of continued training, which is required for requalification.
3. **Guidance Note**: Continued training should improve the knowledge and skills of the RCT in a relevant area.
4. The radiation protection organization and ESH-13 shall offer continued training. **Guidance Note**: Continued training input from the line organizations is encouraged.
5. **Guidance Note**: Continued training should include Laboratory-specific and DOE-wide changes in requirements and updates of lessons learned from operating experience and industry events.

6. **Guidance Note**: Infrequently performed tasks, such as those for emergency response, may require annual training. Other tasks may require retraining before a task is initiated.

7. Personnel who maintain qualifications as RCTs shall be considered to have satisfied the requirements of RW training, GERT, and x-ray safety training.

8. RCTs shall be requalified every two years through comprehensive oral boards in accordance with Article 847 of this chapter.

844 RCT Supervisors

1. RCT supervisors shall be qualified as RCTs and shall participate in continuing radiological training programs.

2. **Guidance Note**: RCT supervisors should have the supervisory and leadership capabilities required to direct the work of technicians; effectively interact with crafts, line supervisors, professional staff, and other managers; and respond and direct others in emergency and abnormal situations.

3. RCT supervisors shall be requalified every two years through comprehensive oral examination boards in accordance with Article 847 of this chapter.

4. **Guidance Note**: Oral examination boards should focus on the RCT supervisor's ability to analyze situations and supervise subordinates. The RCT supervisor's depth of knowledge should exceed that expected of an RCT.

845 Subcontracted RCTs

1. **Guidance Note**: Subcontracted RCTs (including RCTs brought in by contractor organizations, for example, environmental restoration contractors) should have the same knowledge and qualifications required of Laboratory RCTs performing the same duties.

2. **Guidance Note**: At a minimum, the training and qualification program should include the following:

   a. review of resumes to identify technicians with experience in jobs similar to those in which they will be employed,

   b. written examination and oral evaluation to verify the knowledge level in accordance with Articles 846 and 847 of this chapter,

   c. identification of the duties technicians will be authorized to perform,

   d. training in facility procedures and equipment associated with the authorized duties,

   e. training on recent operating experience, and

   f. observation of on-the-job performances by the RCT supervisor.

3. Subcontracted technicians who work at a Laboratory facility for extended periods of time (more than six months) shall be identified by the radiation protection organization and shall receive continued training commensurate with their assigned duties. Continued training shall include successful completion of an oral examination.

846 Qualification Standards for RCTs

1. Qualification standards for RCTs shall define the requirements for demonstrating completion of training. Proficiency shall be documented by signatures on the qualification cards in qualification standards.

2. Qualification requirements from the standard core course shall be used and supplemented by ESH-1 to include Laboratory-specific elements. **Guidance Note**: The Laboratory-specific elements may include input from the line organizations. This input may include information related to operations of the line organization and the hazards associated with these operations.

3. Qualification requirements for the RCT position shall include on-the-job training by ESH-1 for hands-on experience that applies directly to the job.

4. On-the-job trainees shall be placed under the control of qualified personnel. Before performing a job without direct supervision, a trainee with partially completed qualifications shall have completed the qualifications for that task.

847 Oral Examination Board

The oral examination board shall determine the qualification of candidates for RCT and RCT supervisor positions. Members of the oral examination board shall have the opportunity to identify areas of strength and weakness in candidates for RCT duties and supervisor functions. Board members shall also identify qualities that would enhance RCT and supervisor training programs.

1. The Radiation Protection Program manager shall designate the board members and appoint chairpersons.
2. **Guidance Note**: The board should assess the candidate's response to normal and emergency situations. Questions should be of the type that is not normally covered in a written examination. These questions should be based on training objectives.
3. **Guidance Note**: The board constituted to evaluate RCT supervisor candidates should not include RCT peers or subordinates as voting members.
4. Requalification by an oral examination board is required for the first and second requalifications (years two and four). **Guidance Note**: However, for the third and subsequent requalifications (year six and on), the RCT/RCT supervisor may elect to requalify by additional continuing education or a written examination rather than by an oral examination board.

Part 5 Other Required Training

851 Education, Training, and Skills

1. Individuals who are responsible for developing and implementing the measures required for ensuring conformance with the requirements of 10 CFR 835 shall have the education, training, and skills required to discharge these responsibilities [see 10 CFR 835.103]. **Guidance Note**: These individuals can include technical and management personnel within the radiological control organization, independent assessors, and the safety- and environment-responsible line-management chain.
2. Documentation of the education, training, and skills required to discharge the responsibility of implementing the requirements of 10 CFR 835 shall be maintained. **Guidance Note**: This documentation may include training rosters (that is, EDS), qualification statements, school transcripts, and training certificates.
3. The safety- and environment-responsible line-management chain responsible for radiological activities and workers shall either complete Radiological Control Responsibilities for Managers, offered on the web by ESH-13 (course 9523), or keep up with the current RW training to meet the requirement in Article 851.1 of this chapter.

Part 6 Optional Hazard-Specific Radiological Training

Guidance Note: Listed below are optional hazard-specific courses offered by ESH-13 for self-study. The safety- and environment-responsible line-management chain, who are responsible for managing these types of hazards, as well as workers who may be exposed to these hazards, should complete the relevant courses.

Course Number	Course Title
12325	Accelerator Safety
12323	Depleted Uranium Safety
11579	Plutonium Safety
15907	Sealed Source Safety
11952	Tritium Safety
12324	Uranium Safety
12326	X-Ray Safety for Analytical and Industrial Settings

Appendix 8A
Radiological Control Training Requirements

Activities	Minimum Training	Article
Entry to Radiological Controlled Areas by members of the public	Orientation	822
Unescorted[1] entry into Radiological Controlled Areas and Radioactive Material Areas and Underground Radioactive Material Areas where an individual is not likely to receive more than 0.1 rem in a year	GERT	814, 821
Unescorted[1] entry into Radiological Buffer Areas established for external radiation purposes	RW	814, 831, 832
Unescorted[1] entry into Radioactive Material Areas and Underground Radioactive Material Areas (more than 0.1 rem in a year)		
Unescorted[1] entry into Soil Contamination Areas for work that does *not* disturb the soil		
Operating a radiation-producing device		
Unescorted[1] entry into radiation areas, including • Radiation, • High Radiation, and • Very High Radiation Areas		
Unescorted[1] entry into contaminated areas, including • Contamination, • High Contamination, and • Airborne Radioactivity Areas		
Unescorted[1] entry into Soil Contamination Areas for work that *does* disturb the soil		
Working with radioactive material, including the use of containment/confinement devices[2]		
Unescorted[1] entry into Radiological Buffer Areas established for contamination control purposes		
Operating a low-hazard x-ray device	X-Ray Safety (equivalent to RW for external hazards only)	832
Using sealed sources[2]	RW and Sealed Sources Self-Study Training	1623

[1]Refer to Articles 821.3 and 831.4 for escorted entry training requirements.

[2]**Guidance Note**: Because of the prevalence of naturally occurring radioactive material, good judgment should be exercised in applying this criterion. RW training is not triggered by work with consumer products, unprocessed naturally occurring radioactive material, items or material that could be freely released to the public, or material that is exempt from labeling, posting, or storage in a Radioactive Material Area.

Appendix 8B
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radiological Training and Qualifications	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - The appropriate level of radiation protection training for each individual has been identified and documented in a training plan. (Article 814.2)
   - The training plan is reviewed and updated annually based on the radiological hazards to which the individual is exposed. (Article 814.9)
   - Individuals will have completed radiation safety training covering the topics listed in Article 814.1 before they are given unescorted access to RCAs or to RMAs and URMAs where they are not likely to receive greater than 0.1 rem (0.001 sievert) in a year, and before they receive occupational radiation exposure during access to RCAs (whether escorted or not). (Article 821.1)
   - When escorts are used in lieu of training, the escort has the same level of training required for entry into the area and work to be performed. The escort ensures that the escorted individual complies with the radiation protection program. (Article 821.3)
   - Members of the public receive radiation safety training covering the topics in Article 814.1 before being allowed access to RCAs. (Article 822)
   - Before unescorted access to RBAs and radiological areas, or performing work as a radiological worker, individuals complete RW training that is commensurate with the hazards and controls in the area. (Article 831.1)
   - X-ray safety training without RW training is permitted for the low-hazard x-ray devices listed in Article 832.1. The operation of other x-ray devices requires both RW and x-ray safety training. (Article 832)
   - Individuals who may be assigned to perform emergency actions that could lead to exceeding the dose limits of Table 4-1 have successfully completed RW training or the combination of Emergency Responder Radiological Training (course number 15664) and the Emergency Responder Radiological Training Drill (course number 17793). (Article 833.1)
   - Individuals who are responsible for developing and implementing the measures necessary for ensuring conformance with the requirements of 10 CFR 835 will have the education, training, and skills necessary to discharge these responsibilities. These individuals can include technical and management personnel within the radiological control organization, independent assessors, and the safety- and environment-responsible line-management chain. Their education, training, and skills have been documented and maintained as records. (Article 851)

Access Control

Contents

Access Control

Appendix 9C of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

911 General Requirements

Who	Shall
The safety- and environment-responsible line-management chain	Ensure that equipment and areas are controlled to prevent inadvertent radiation exposure to personnel.
Radiological workers	Implement required hazard control plans (HCPs), radiation work permits (RWPs), or other work control documents to ensure that access control requirements are implemented.
Health Physics Operations (ESH-1)	• Survey areas requiring access control. • Provide data on dose rates and contamination levels to operating personnel. • Assist the safety- and environment-responsible line-management chain in implementing access-control requirements and providing additional expertise.

Part 2 Entry and Exit Requirements

921 Radiological Controlled Areas (RCAs)

1. DOE regulations for occupational radiation protection require that individuals complete radiation safety training commensurate with the hazards and required controls in the following situations:
   a. before unescorted access to RCAs [see 835.901(a)] and
   b. before receiving occupational dose during access to RCAs (whether escorted or not) [see 835.901(a)].
2. Training requirements that shall be met for unescorted entry into RCAs and radiological areas are specified in Appendix 8A, chapter 8. Article 822, chapter 8 establishes training provisions that shall be met before members of the public are permitted to enter RCAs.
3. Facility matrixes shall specify internal and external dosimetry specific to the RCA. The facility ESH-1 team leader or radiological control technician (RCT) shall be contacted for further information.
4. Personal protective equipment (PPE) requirements for RCAs established for contamination control shall be as described in Article 1023.6, chapter 10.
5. Personnel exiting RCAs established for contamination control shall perform a hand and foot frisk. Areas containing only tritium shall require alternative controls such as tritium bioassay and area contamination surveys.

922 Radiological Buffer Areas (RBAs)

1. Minimum requirements for unescorted entry into RBAs shall be as follows:
   a. training in accordance with Appendix 8A, chapter 8 and
   b. internal and external dosimetry specific to the facility, area, and activity as required by the RWP and/or facility matrices. The facility ESH-1 team leader or RCT shall be contacted for further information.
2. PPE requirements for RBAs controlled for contamination shall be as described in Article 1023.6, chapter 10.

3. Contamination monitoring provisions for individuals who exit an RBA containing Contamination Areas, High Contamination Areas, or Airborne Radioactivity Areas shall be as specified in Article 1425, chapter 14.

923 Radioactive Material, Soil Contamination, and Underground Radioactive Material Areas

Minimum requirements for unescorted entry into Radioactive Material Areas, Soil Contamination Areas, and Underground Radioactive Material Areas (URMAs) shall include training in accordance with Appendix 8A, chapter 8. The work control document (for example, RWP) and/or facility matrixes shall require internal and external dosimetry specific to the facility, area, and activity. The facility ESH-1 team leader or RCT shall be contacted for further information.

924 Radiation, High Radiation, and Very High Radiation Areas

1. Minimum requirements for entry into Radiation Areas shall include the following:
   a. training in accordance with Appendix 8A, chapter 8;
   b. written authorization to enter and/or perform work in the radiation area using the required work control document [see 835.501(d)]; and
   c. primary "dose of record" dosimeter and other required external dosimetry.
2. **Guidance Note**: Physical controls to prevent inadvertent or unauthorized access to High and Very High Radiation Areas are listed in Appendix 9A of this chapter. Additional physical controls for accelerators and radiation-producing devices/facilities (see Glossary) are listed in Appendix 9B of this chapter.
3. Minimum requirements for entry into High Radiation Areas shall include the following:
   a. training in accordance with Appendix 8A, chapter 8;
   b. written authorization to enter and/or perform work in the High Radiation Area using the required work control document [see 835.501(d)];
   c. an RWP;
   d. a primary "dose of record" dosimeter and other required external dosimetry [see 835.402(a)(5)];
   e. a radiation survey (refer to Article 622.1, chapter 6); and
   f. a supplemental dosimeter or other means capable of providing an immediate estimate of the individual's integrated deep dose equivalent during the entry (refer to Article 521.2a, chapter 5 [see 835.502(a)].
4. Minimum requirements for entry into High Radiation Areas where dose rates are high enough that an individual could exceed a whole-body dose of 1 rem (0.01 sievert) in one hour shall include the items listed in Article 924.3 above and the following:
   a. a determination of the individual's current dose, based on primary and supplemental dosimeter readings;
   b. pre-job briefing, as required; and
   c. review and determination by ESH-1 regarding the required level of RCT coverage.
5. Individuals shall be prevented from unauthorized or inadvertent entry to Very High Radiation Areas [see 835.502(c)]. In addition to the controls required in Articles 924.2, 924.3, and 924.4 above, ESH-1 shall perform a survey before each entry to the area after the source of the Very High Radiation field has been secured or shielded to verify the termination of the field. Under normal conditions, access to Very High Radiation Areas shall not be allowed. Only under the most strict control shall access be allowed to an area where these radiation levels may be present. If the general work area is found to be a Very High Radiation Area, entry shall immediately cease, personnel shall exit the area, and further entry shall be denied until dose rates drop to those characterizing a High Radiation Area.
6. Operations personnel shall immediately notify ESH-1 of operational or system changes that could result in significant changes in radiological hazards. Such notifications shall be required to allow ESH-1 to post areas

and to assist the safety- and environment-responsible line-management chain with implementation of the required entry controls.

7. The number, issue, and use of keys shall be strictly controlled wherever locked entryways are used to control access to High and Very High Radiation Areas.

8. Physical access controls shall not prevent the exit of individuals from High and Very High Radiation Areas under emergency conditions [see 835.501(e)].

925 Contamination, High Contamination, and Airborne Radioactivity Areas

1. Minimum requirements for entry into Contamination Areas shall include the following:

   a. training in accordance with Appendix 8A, chapter 8;

   b. written authorization to enter and/or perform work in the Contamination Area using the required work control document [see 835.501(d)];

   c. internal and external dosimetry as required by the RWP/HCP/work control document/posting and/or facility matrixes (contact the facility ESH-1 team leader or RCT for further information); and

   d. protective clothing [see 835.1102(e)].

2. Minimum requirements for entry into High Contamination or Airborne Radioactivity Areas shall include the following:

   a. training in accordance with Appendix 8A, chapter 8;

   b. written authorization to enter and/or perform work in the High Contamination or Airborne Radioactivity Area using the appropriate work control document [see 835.501(d)];

   c. an RWP;

   d. respiratory protection when specified by the RWP;

   e. pre-job briefing for High Contamination or Airborne Radioactivity Areas;

   f. internal and external dosimetry as required by the RWP/HCP/work control document/posting and/or facility matrixes (contact the facility ESH-1 team leader or RCT for further information); and

   g. protective clothing [see 835.1102(e)].

3. Individuals exiting Contamination, High Contamination, or Airborne Radioactivity Areas shall remove protective clothing in accordance with Laboratory and facility requirements. When entering an uncontaminated area, these individuals shall be monitored for the presence of contamination on their skin and clothing [see 835.1102(d)]. These individuals shall perform whole-body frisking to detect personnel contamination in accordance with Article 1425, chapter 14.

4. Exit points from Contamination, High Contamination, or Airborne Radioactivity Areas shall include

   a. a step-off pad located outside the exit point, contiguous with the area boundary;

   b. step-off pads kept free of radioactive contamination, as practicable;

   c. designated containers inside the area boundary for collecting protective clothing and equipment; and

   d. contamination-monitoring equipment located as close to the step-off pad as background radiation levels permit.

5. Multiple step-off pads shall be used at the exits from High Contamination Areas.

6. Protective clothing and monitoring requirements specific to bench tops, laboratory fume hoods, sample stations, and glove boxes shall be as identified in Article 1426, chapter 14.

7. Tools or equipment being removed from areas posted for removable surface or airborne radioactivity control shall be surveyed for release or for retention in a contaminated-tool crib [see 835.1101(a)] in accordance with Articles 1431, 1432, and 1433, chapter 14.

926 Entry Requirements for Members of the Public

1. Facility procedures shall identify entry requirements (including external and internal dosimetry requirements, see Article 926.4 below) and access restrictions for members of the public.
2. Members of the public who are required to enter the following areas shall be allowed access only if such access is controlled with a combination of orientation and the use of escorts trained for the specific area:
   a. Radiological Controlled Areas (RCAs)
   b. Radiological Buffer Areas (RBAs)
   c. Radiation Areas
   d. Contamination Areas
   e. Radioactive Material Areas
   f. Soil Contamination Areas
   g. Underground Radioactive Material Areas (URMAs)
3. Members of the public shall not enter Very High Radiation, High Radiation, High Contamination, and Airborne Radioactivity Areas.
4. Members of the public entering the areas listed in Article 926.2 above must be evaluated to determine if they are likely to exceed 25% of the limit specified in Article 423, chapter 4 (0.025 rem), as a result of the current visit. If they are likely to exceed 25% of the limit for the current visit, they shall be evaluated with respect to the matrix for the facility they are visiting and assigned to the required external and/or internal dosimetry program.
5. If external dosimetry is required for members of the public entering the areas listed in Article 926.2 above, each member of the public entering the area must be issued the required dosimetry. A “tour” TLD dosimeter for a group of individuals, such as members of the public, shall not be used. Each individual assigned a TLD dosimeter must complete a Temporary Badge Identification Card (Form 972) available from group dosimeter custodians and ESH-4 Personnel Dosimetry Operations.

927 Wounds in the Potentially Contaminated Workplace

1. Individuals with open sores or wounds (including cuts, scabs, or rashes) on their skin shall be evaluated and cleared by Occupational Medicine (ESH-2) before starting work in an RCA controlled for contamination purposes, an RBA established for contamination control purposes, a disturbed Soil Contamination Area, URMA, Contamination Area, High Contamination Area, and Airborne Radioactivity Area; or starting work on unsealed radioactive materials on bench tops, in hoods, or in glove boxes.
2. **Guidance Note**: Depending on the location of the wound and type of work being performed, proper bandaging and protection of the open sore or wound may block the possible intake of radioactive material.
3. ESH-2, in consultation with the work group supervisor and ESH-1, shall make the decision as to whether a wound can be protected from contamination.

Appendix 9A
Required Controls for Areas Posted for Radiological Hazards

The levels of control listed below shall be implemented according to increasing degrees of control. A higher numerical control level shall meet the requirements of a lower level (for example, level 2 is satisfactory when only level 1 is required).

Level	Criteria
Level 1	Administrative controls and/or signs and barricades, or any level 2 control
Level 2	One or more of the following shall be used at access points to control entry or occupancy: • A control device that prevents entry to the area when radiological hazards that define the area are present or that, upon entry, causes the radiation hazard to be reduced below that defining level • A device that functions automatically to prevent the creation of a radiological hazard while personnel are in the area • A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the area and the supervisor of the activity are made aware of the entry • Entryways that are locked. During periods when access to the area is required, positive control over each entry must be maintained • Continuous direct or electronic surveillance that is capable of mitigating unauthorized entry • A control device that will automatically generate audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in enough time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source
Level 3	In addition to a level 2 control, at least one other measure shall be implemented to ensure that individuals are not able to gain inadvertent or unauthorized access.

Areas posted for radiological hazards shall be controlled, at a minimum, to the levels specified in the table below.

Area Designation	Control Level
RCA/RBA for external radiation	1
RCA/RBA for contamination	1
RCA for depleted uranium shrapnel	1
RCA for volume contamination	1
RMA, Soil Contamination Area, and URMA	1
Radiation Area and High Radiation Area that is less than or equal to 1 rem (0.01 sievert) in 1 hr	1
High Radiation Area that is greater than 1 rem (0.01 sievert) in 1 hr	2
Very High Radiation Area	3
Contamination Area	1
High Contamination Area	1
Airborne Radioactivity Area	1

Appendix 9B
Accelerator and Radiation-Producing Device (RPD) Access Control

The requirements in Table 1 and Table 2 of this appendix shall be specific to those operations conducted within fixed, shielded installations (as defined in ANSI N43.3-1993) where personnel could gain access to the exclusion area (either partially or totally entering the exclusion area.).

Those accelerator and RPD operations conducted in the open (open installations) must meet the requirements of Article 924 of this LIR.

1. **Guidance Note** (**philosophy of accelerator/RPD access control)**: The access-control system described in this appendix has been developed to *limit worker radiation exposure.* Since the system prescribed in this appendix is the last line of defense that prevents inadvertent exposure (and indeed may be the only means to prevent access to an area where personnel may receive very significant doses), the system must be independent of equipment protection systems, very robust, and fail-safe. Accelerator and RPD areas are generally defined by the ease with which the radiation level can be returned to a safe state. Since prompt radiation or RPD radiation is easily controlled, personnel exposure dose rates are easy to limit using safety systems. Radiation containment and access-control systems may use both active and passive controls (such as current limiting toroids, door switches, or configuration-controlled barriers). Credit should NOT be taken for other operational safety systems used to prevent damage to equipment unless both independence and "fail safety" are incorporated into the hardware protection safety system. System independence should be used to reduce the likelihood that an individual may be exposed to high levels of radiation from a single event, multipoint chain failure (that is, one single system failure causes several systems to fail at once).

2. **Graded Approach**. This appendix defines "graded" requirements that shall be implemented for access control based on the level of hazard expected from the accelerated beam or RPD.

   Guidance Note: Accelerators and nonradioactive-source RPDs (for example, x-ray devices) are controlled differently from RPDs using radioactive sources in that the immediate hazard from accelerators and nonradioactive-source RPDs is "prompt" radiation, which is simply controlled by blocking or turning the beam off. The radiation hazard associated with radioactive sources can be removed only by physically moving the source into a shielded enclosure.

   Access-control systems shall consist of a series of administrative and hardware elements, as listed below, that when combined form a defense-in-depth system designed to tightly control access to hazardous radiological areas:

   a. enclosures and barriers

   b. search and warning procedures

   c. resets and scram switches

   d. access-control system hardware

   e. locked entries

   f. independent system shut down system

   g. configuration control

   h. quality control

   This appendix describes a functional system that shall be implemented to (1) prevent high levels of radiation from the operation of an accelerator beam or RPD from reaching personnel working in areas open for unrestricted occupancy; (2) prevent personnel from inadvertently entering areas where beam delivery is enabled or the RPD is on or exposed; and (3) facilitate safe and efficient transition between beam-off and beam-on/exposure-off and exposure-on modes at accelerators or RPDs.

This appendix establishes a functional requirement that shall be implemented to meet this objective. An alternative approach that provides equivalent safety or efficiency shall also meet the purpose of this appendix. The functional requirements shall include automation of routine tasks and a graded approach with an increasing level of safety depending upon radiation levels as shown in Table 1 and Table 2 of this appendix. The radiation levels in the tables shall be the highest levels expected during normal operation.

3. **Enclosures and Barriers**. Areas that become High Radiation Areas or Very High Radiation Areas from prompt radiation or from RPDs shall be enclosed to prevent access while the condition is present (except for those operations that must be conducted out in open areas, such as field radiography). An enclosure shall consist of physical barriers capable of preventing inadvertent entry. When the enclosure is not complete in three dimensions, or is readily circumvented, the outside face of the barrier shall be posted indicating its purpose; examples of required barriers include a six-foot-high chain link fence or shield wall, and the walls of a building. If a barrier is readily moveable, it shall be interlocked so that the beam is inhibited or the source is stored and shielded when the barrier is moved, or configuration controlled in a way that will prevent removal. Redundant barrier interlocks shall be required as indicated in Table 1 and Table 2 below. Barrier design shall include possible contributions from sky shine.

Table 1. Required Accelerator Access Controls and Recommended Additional Features

The conditions in one row shall apply from the listed radiation level up to the level for the next row.

Above dose/h [a]	First required interlock	Second required interlock	Required procedures	Required status indicators	Guidance Note: Recommended additional features
0.005 rem (0.05 mSv)	none	none	none	warning barrier and posting	radiation alarm interlock, or gate interlock
0.1 rem (1 mSv)	gate or radiation	none	search and warning	radiation alarm or status indication	gate release interlock
5 rem (0.05 sievert)	gate	none	search and warning	status indication	gate release interlock; gate or radiation interlock
25 rem (0.25 sievert)	gate	gate or radiation	search and warning	status indication	gate release interlock

[a]Dose/h: Highest possible dose equivalent if a person were exposed in the area for one hour.

Table 2. Required Access Controls for Radiation-Producing Devices and Recommended Additional Features (in Radiation-Producing Facilities)

The conditions in one row shall apply from the listed radiation level up to the level for the next row.

Above dose/h[a]	First required interlock[b]	Second required interlock[b]	Required procedures	Required status indicators	Guidance Note: Recommended additional features
0.1 rem (1 mSv) @ 1 ft	administrative control	none	search and warning	radiation alarm or status indicator	None
1 rem (10 mSv) @ 1 ft	gate or shield barrier	none	search and warning	status indicator	visible or audible warning signal[c], gate release interlock, gate or radiation interlock
500 rad (5 grays) @ 100 cm (1 meter)	gate or shield barrier	gate or radiation	search and warning	visible and audible warning signal[d], status indicator	additional gate or shield barrier interlock, gate release interlock

[a]Dose/h: Highest possible dose equivalent if a person were exposed in the area for one hour.

[b]Interlock shall be fail-safe and shall cause the radiation level within the exclusion area to be reduced below 0.1 rem (1 mSv) in any hour upon entry, or in the case of an x-ray device, result in the disconnection of the energy supply circuit to the voltage generator and this disconnection shall not be dependent upon any moving part other than the door. Additional interlocks shall function independently of each other (that is, only one of the interlocks need function to return the source to it's shielded position or disconnect the energy supply to the device) and provide redundancy.

[c]Visible signal (preferably of the rotating beacon type) shall actuate whenever the radiation exposure rate exceeds 0.1 rem/hr (1 mSv/hr) in the exposure area and shall remain actuated during the entire exposure duration. The audible signal (not less than 10 dB above the overall maximum typical ambient noise level, and in any case, not less than 75 dB [referenced to $\mu N/m^2$]) shall be activated if an interlocked access to the exclusion area is opened and the radiation dose rate exceeds 0.1 rem/hr (1 mSv/hr). The signal shall be audible to the operator of the RPD and to the person entering the exclusion area.

[d]Both the visible (see footnote 2 above for criteria) and audible (see footnote 2 above for criteria) signal shall actuate a minimum of 20 seconds immediately before irradiation can be started. The visible signal shall remain on throughout the exposure period. The audible signal need not remain on during the exposure period, but shall be actuated if an interlocked access to the personnel exclusion area is opened and the radiation dose rate exceeds 0.1 rem/hr (1 mSv/hr). The signal shall be audible to the operator of the RPD and to the person entering the exclusion area.

4. **Exclusion Areas with Routine Access**
When access limitations routinely alternate between High Radiation Area and Radiological Controlled Area, entry requirements (that is, beam on/beam off or source exposed/unexposed), the area shall be equipped with an access system (gate, barrier or radiation detection-based interlock) which incorporates the features shown in Table 1 or Table 2 above. Provided below is an explanation of physical and administrative access controls that shall apply to accelerators and RPDs.

a. **Beam Stoppers**. Accelerators shall be equipped with beam stoppers or systems designed to completely shut off the beam. These components must be designed to handle the beam power deposited on them. They must also be fail-safe, redundant, and independent of equipment protection safety systems.

b. **Gate Interlocks**. A gate interlock shall inhibit the beam, turn off the RPD, or move the source to a shielded enclosure when the gate is open. When gate interlocks are required by Table 1 or Table 2 above, the gate

shall be locked from the outside during beam delivery, RPD operation, or source exposure. The lock shall not prevent personnel from leaving the area.

c. **Radiation Interlock**. A radiation interlock shall inhibit the accelerator beam if the radiation instrument output exceeds a preset level in occupied areas. **Guidance Note**: The radiation interlock signal may also be used to inhibit door entry when doses exceed a certain level.

The radiation interlock shall limit personnel dose to levels that are less than those required to trip the interlock. When a second radiation interlock is used, the two systems must provide independent and redundant protection equivalent to a second gate interlock.

Note: Radiation interlocks shall only be used in situations where radiation can be directly measured as a result of beam on conditions. If the radiation interlock detects radiation only when beam is spilled, a radiation detection system shall not be used as a personnel exclusion interlock. Furthermore, radiation interlocks shall not be used in areas where radiation damage may cause the electronics to fail.

d. **Gate Release Interlock**. An electronic system that shall be designed so that when an individual plans to enter a door or gate, he must first request a "Key Release" from the accelerator or RPD operators. The released key shall be used to unlock a bank of kirk keys from the key bank.

Guidance Note: Alternatively, the key that opens the door cannot be released unless the accelerator or RPD is not operating at the point of entry.

e. **Shield Barrier Interlock**. A shield barrier interlock shall be the same as a gate interlock with the exception that the shield shall be a mobile shield which is readily moved and must be interlocked to prevent entry.

f. **Search and Warning**. When accelerators or RPDs produce radiation in excess of > 0.1 rem/hr (1 mSv/hr), procedures for administrative area sweeps shall be initiated. These sweeps shall be performed in all areas where 0.1 rem/hr (1 mSv/hr) can be exceeded. Sweep procedures shall prevent access by personnel other than sweep personnel to the beam line tunnels or exposure room while the sweep is in progress.

g. **Resets and Scrams**. Before a beam is turned on or a source is exposed in an area that will become a personnel exclusion area (dose rates greater than 0.1 rem/hr [1 mSv/hr]), the area must be searched as required in section 4.g above. When an area cannot be completely observed from each gateway, search reset switches shall be provided in both accelerators and RPFs to ensure a complete search before beam or radiation is allowed in the area. Each switch must be enabled before radiation production (for example, beam on or source exposure) begins. In addition, the following requirements shall be implemented:

- An emergency beam-inhibit system shall be installed at regular intervals in accelerator beam tunnels. These shall be designed to allow personnel left inside beam tunnels during the administrative sweep a rapid means of inhibiting the beam.
- Installations using RPDs for irradiation shall provide scram switches within the exclusion area, which, when actuated, return the source to a safe configuration or otherwise terminate the exposure.
- A scram switch shall not be required for personnel exclusion areas when the entire area is visible from the operator's console through a window or a closed circuit television system looking into the area. **Guidance Note**: In some cases, this may require mirrors that will allow the operator to see into corners or under tables from the window or television camera. **Guidance Note**: Although a scram switch is not required for this situation, the installation of one is recommended.
- A scram switch shall not be required for those areas intended to be occupied during the creation of a high radiation area.
- Doors within each type of facility shall be equipped with exit hardware that meets or exceeds the life safety code requirements and shall not be blocked to prevent exit from the exclusion area.

h. **Warning**. Audible warnings, such as horns, buzzers, and public address system announcements, shall be given before an accelerator or beam delivery system is allowed to produce radiation, or a source is exposed, in an exclusion area.

The tone and characteristics of an audible warning shall be distinctive from any other signals used at a facility and shall use the same tone throughout the facility where it is incorporated. Footnotes 2 and 3 of Table 2 above shall be referred to for further RPD warning signal requirements.

i. **Area Secure System**. An area secure system shall include internal logic to enforce correct completion of the sequence to make the area ready (secure) for beam delivery or RPD exposure. The sequence shall include search-locked beam warning steps. The area secure system shall be capable of keeping the beam or RPD (any beam that could cause a High or Very High Radiation Area) inhibited for a preset time after the warning or inhibiting the beam or RPD if the sequence is not correctly executed.

j. **Beam or RPD Enable Request**. The search and warning process shall include a step that requires personnel to request beam delivery before allowing the interlock system to uninhibit the beam. **Guidance Note**: The request should be made by a person switching the area mode to beam-ready.

The search and warning process shall include a step that requires the individual operating the RPD either to request or personally initiate the production of radiation from the RPD.

k. **Required Status Indicators**. An indication of the status of a radiological area shall be visible or audible by each entryway. Although a locked gate shall be the minimum acceptable indication of an exclusion area, automatically switched signs shall be required for interlocked areas.

If a radiation alarm is used as a status indicator in a non-exclusion area, it shall be visible or audible throughout the area.

5. **Configuration Control Requirements**

a. **Access Interlock System**. A configuration control process for the access interlocks shall be in place to provide an up-to-date system description with as-built drawings and to prevent unauthorized modifications of the system. The access-control system shall be enclosed in tamper-proof hardware; only trained personnel shall be authorized to work on the system. System changes shall require on-the-job training for maintenance and operation system personnel.

b. **Barrier Inspections**. Surveys of areas secured with a controlled padlock to prevent personnel access shall be completed weekly. (**Guidance Note**: This survey does not include those areas where an active PSS system will shut down the accelerator to prevent access since these areas are checked electronically to ensure integrity.) The outer boundaries of the accelerator access control system shall be surveyed to ensure integrity each time before the accelerator run cycle begins as part of the routine PSS system startup checklist.

c. **System Bypasses**. Access-control system bypasses shall be strictly controlled. Operations-responsible managers shall designate a limited number of personnel who shall have the authority to approve bypasses. Two or more qualified individuals must review the bypass implications before the bypass takes place. The following requirements must also be implemented.
- A system bypass logbook shall be kept to document each bypass.
- Systems shall not be bypassed for routine operation.
- System operators shall review the system bypass log at the beginning of each shift as part of the shift turnover process.
- Bypassed systems shall be returned to their original state as soon as the bypass is no longer needed.
- System bypasses shall be examined at the beginning of each shift to see if they are still necessary.
- When operations-responsible managers decide to make a bypass part of the access-control system, the change shall be approved by the system group leader and an independent safety committee, and shall be documented in the access control system documentation (for example, operations manual).

6. Tests and Maintenance

a. **Personnel.** Personnel who test, inspect, or maintain access-control systems shall be specifically designated by the safety- and environment-responsible line management chain, shall meet required qualifications, and shall be familiar with the design and functions of the systems being tested or inspected.

b. **Documentation**. Tests, inspections, and maintenance shall be documented. **Guidance Note**: A recommended type of documentation for tests and inspections is a checklist.

The documentation shall be retained in accordance with Section 7 of this appendix.

c. **Procedures**. Facility-specific procedures, checklists, or equivalent instructions shall be used to conduct tests, inspections, and maintenance, and such documents shall specify the frequency and the methods used.

d. **Operational Tests**. Access-control systems for accelerators and RPDs that are in use shall be operationally tested at least annually or before startup if the accelerator or RPD has not been operational for a period of three months. The system shall be tested after it has been modified to verify that it is performing correctly.

Before initiating beam delivery or RPD operation for a continuous operating period, the access-control system to an area shall be tested if
- a test has not been performed in the preceding 6 months,
- configuration control has not been maintained continuously, or
- the system has not been regularly maintained.

Operational tests shall exercise each system input and verify the required protective response. The independent functioning of redundant access-control subsystems shall be verified.

e. **Calibration**. Radiation detection instruments that are part of access-control systems shall be calibrated annually.

7. Documentation

a. The following documentation shall be prepared and retained for access-control systems.
- **Guidance Note**: A historical file of standards and guides should be retained permanently.
- Interlock test and inspection results shall be retained for one year if unusual radiation data are posted to other records, which are retained for the life of a facility.
- A record of the physical and electrical configuration of the current system shall be maintained.
- A description of the current document control and review system for keeping documentation complete, accurate, and current shall be maintained.
- Reports of incidents related to access-control system failures that result in accidental exposures shall be retained permanently.
- Special work permits (SWPs) pertaining to access-control systems shall be retained for one year after they expire.
- Procedures associated with the current access-control system shall be maintained and updated every three years or as needed.
- Maintenance documentation shall be retained for three years.
- A history of calibration procedures and schedules that gives the frequency of calibration and maintenance of radiation detection instruments and equipment used in access-control systems shall be retained permanently.
- The physical status, statistical data, operating condition, and any other related data associated with instruments used in access-control systems shall be retained until their purpose has been served, up to one year.

b. Charts, logs, and other documents used with alarm systems to record radiation in excess of established facility-specific requirements shall be retained for one year if unusual radiation data are posted to other records, which shall be retained for the life of a facility.

Appendix 9C
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Access Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.
2. The recommended major implementation criteria for self-assessment of this chapter are the following.
   Note: The article number is given with each bullet to help the reader find more information.

   - Entry and exit control requirements are met for RCAs, RBAs, Radioactive Material Areas, Soil Contamination Areas, Underground Radioactive Material Areas, and Radiological Areas as delineated in Articles 921, 922, 923, 924, and 925.
   - Facility procedures identify specific area entry requirements and access restrictions for members of the public. (Article 926.1)
   - Members of the public are only allowed to enter those areas listed in Article 926.2 under escort.
   - Members of the public are evaluated to determine if they are likely to exceed 25% of the 0.1 rem (0.001 sievert) rem TEDE annual dose limit as a result of the current visit. If they are likely to exceed 25% of the limit for the visit they are assigned to the appropriate internal and/or external dosimetry program. (Article 926.4)
   - Access controls for RCAs, RBAs, and Radiological Areas are implemented in accordance with the requirements of Appendix 9A.
   - Access controls for accelerators and radiation-producing devices are implemented in accordance with the requirements of Appendix 9B.

Personal Protective Equipment

Contents

Personal Protective Equipment

Appendix 10A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1011 General Requirements

Who	Shall
The safety- and environment-responsible line-management chain	Ensure that required protective clothing and other types of personal protective equipment (PPE) are available for the hazards associated with the work.
Radiological workers	Wear the personal protective equipment required by radiation work permits (RWPs), hazard control plans (HCPs), other work control documents, postings, or as directed by the radiological control technician (RCT)
Health Physics Operations (ESH-1)	Establish and communicate PPE requirements in accordance with this chapter and provide additional assistance in the use of PPE as identified in RWPs, HCPs, and other work control documents.

Part 2 Using Personal Protective Equipment (PPE) and Clothing

1021 General PPE Requirements

1. A graded approach shall be used to determine the level of personal protective equipment and clothing (PPE) required. Based on the level of the hazards to which the workers will be exposed, PPE shall be selected, approved, and distributed. The safety- and environment-responsible line-management chain in conjunction with ESH-1 shall determine the radiological hazards and select the protective equipment required to mitigate the radiological hazards. Other ESH personnel (for example, ESH-5, Industrial Hygiene and Safety) shall assist in determining PPE requirements when nonradiological hazards might be present.

2. PPE shall be designed and constructed for safety and shall be durable enough for its intended use. Procurement of PPE shall take these criteria into account. PPE shall be inspected, maintained, laundered, repaired, cleaned, and disinfected.

3. **Guidance Note**: Examples of Laboratory-approved PPE include the following: impermeable gloves, lead-lined gloves, shoe covers, booties, lab coats, anti-C coveralls, hoods, skull caps, face shields, goggles, air-purifying respirators, supplied air breathing apparatus, air line bubble hood/suits, and lead aprons.

4. Individuals shall be trained to use PPE as required. The training shall be provided before an individual is allowed or required to wear the PPE, and completion of the training shall be documented by ESH-5 for respiratory protection equipment and by the ES&H Training Group (ESH-13), for standard protective clothing. Radiological worker (RW) training shall suffice as training for the use of standard protective clothing. Workers shall not be assigned tasks requiring the use of breathing or respiratory PPE until it has been determined that they are physically able to perform the work while using the PPE.

5. Deviations from the use of PPE as discussed in this chapter shall be permitted in special circumstances. (Examples include heat stress caused by PPE or a situation in which the total effective dose equivalent [TEDE] must be minimized.) Such deviations must be documented and authorized by the ESH-1 team leader and, when other hazards are present, by ESH-5.

6. PPE shall be used after other practical protection options have been applied. Other types shall include engineering measures such as containment, confinement, ventilation controls, shielding, sealing, filtration, and decontamination.

1022 Selecting and Maintaining PPE

1. Personnel shall wear protective clothing during the following activities:

   a. handling contaminated materials with removable contamination in excess of the levels specified in Table 14-1, chapter 14;

   b. working in Contamination, High Contamination [see 835.1102(e)], and Airborne Radioactivity Areas; and

   c. as directed by the RCT, as specified on the entry posting, or as required by the HCP, RWP, or other work control documents.

2. Using lab coats as radiological protective clothing shall be authorized for limited applications in which the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Lab coats shall not be used as protective clothing for performing physical work activities in Contamination, High Contamination, and Airborne Radioactivity Areas.

   Guidance Note: Personal clothing may be worn under lab coats. Personal clothing (such as underwear) may also be worn under protective coveralls except in the following situations:

   a. when removable contamination levels in the workplace are expected to exceed those specified in Table 14-1, chapter 14 or

   b. when directed otherwise by ESH-1.

3. Radiological protective clothing needs may be different for tritium areas than for other radiological areas; therefore, where differences exist, they shall be specified in HCPs, RWPs, or other work control documents.

4. Cleaned personal protective equipment (such as face shields and respirators) that comes into contact with the wearer's face and Laboratory-issued nonpersonal protective clothing shall be surveyed before it is used again.

5. Lab coats that are monitored fully and found not to exceed the values specified in Table 14-1, chapter 14, may be reused by the same individual, but must be laundered or discarded after one week. Lab coats that are not fully monitored must be changed after each use. This requirement shall apply to protective clothing but not to precautionary clothing.

6. Coveralls that are monitored fully and found not to exceed the values specified in Table 14-1, chapter 14, may be reused by the same individual (taking personal hygiene into consideration), but must be laundered or discarded twice a week. Coveralls that are not fully monitored must be changed after each use. This requirement shall apply to protective clothing but not to precautionary clothing.

7. Part 3 of this chapter shall be referred to for respiratory protection program requirements.

1023 Conditions for Using PPE

1. Radiological protective clothing shall not be worn in uncontrolled areas except (1) during emergencies, (2) in designated commingling areas, (3) while proceeding between dress-out areas and work areas before initial entry, or (4) when escorted by an RCT for special work.

   Guidance Note: Because of existing facility design and PPE requirements, some commingling areas at the Laboratory allow personnel wearing protective clothing to commingle with personnel wearing personal clothing.

2. Protective clothing worn in Radiological Controlled Areas (RCAs) must be surveyed (either by an RCT using portable survey instrumentation or by a whole-body contamination monitor such as the "PCM-2") before the individual wearer departs from the controlled area into an uncontrolled area. In circumstances where surveys have not been performed before entry into the uncontrolled area (for example, evacuations and orderly exits), the uncontrolled area shall be surveyed for contamination.

3. Personnel wearing shorts, skirts, dresses, or sandals shall not enter areas controlled for contamination. Pants that cover the legs and closed shoes that cover the entire foot shall be worn in areas controlled for contamination.

4. Personnel entering RCAs, RBAs, and radiological areas controlled for contamination shall implement the posted protective clothing requirements. Instructions for donning and removing protective clothing shall be posted at the dress-out and step-off pad, included in work control documents, or given by RCTs in attendance.
5. Laundry shall be received, used, segregated, returned, and disposed of according to current contractual requirements or facility-specific procedures.
6. The minimum acceptable radiological protective clothing or precautionary clothing (see Article 1024) requirements for entering radiological controlled areas (RCAs and RBAs) where a potential for contamination is present shall be based on a documented hazards analysis (for example, HCP) for the facility or activity based on the potential for removable contamination and the type of work to be performed.
7. An impermeable outer coverall and hood shall be considered a second layer of protective equipment in areas with the potential for liquid spills. Both the radiological and nonradiological hazards presented by the radioactive/hazardous material or condition must be considered. ESH-5 personnel must be contacted for assistance with nonradiological hazards.
8. This table specifies the minimum radiological protective clothing that shall be required for entry into selected radiological areas.

For this area . . .	**and this situation . . .**	**this level of protective clothing shall be worn.**
Contamination Area or High Contamination Area	routine entry	Level I[a]
	heavy work	Level II[b]
Airborne Radioactivity Area	any	Level I[a], hood (required replacement for skull cap), and required respiratory protection equipment

[a]Level I clothing: one pair of coveralls, two pairs of latex gloves (inner pair taped), one pair of booties, and skull cap (or hood).
[b]Level II clothing: two pairs of coveralls, two pairs of latex gloves (inner pair taped), two pairs of booties, and hood

9. When gloves are required, they must be impermeable and suitable for the hazard present in the area. Cotton gloves may be worn under the impermeable gloves for comfort, but they shall not be considered PPE.
10. If cotton or synthetic protective clothing is being worn during flame- or spark-producing operations, the clothing must meet, or be treated to comply with, specific flame-resistance performance criteria (consult ESH-5 for guidance).
11. ESH-1 shall review the applicable line organization's HCPs and other work control documents to ensure that radiological protective clothing meets the requirements described in this chapter.
12. In accordance with the requirements of this chapter, the RCT shall specify on the RWP the radiological protective equipment to be worn.
13. Deviations from radiological PPE requirements specified in this part must have the concurrence of the ESH-1 team leader.

1024 Precautionary Clothing

1. **Guidance Note:** Precautionary clothing is a level of PPE below level 1 protective clothing that may be used in RCAs, RBAs, RMAs, Underground Radioactive Material Areas (URMAs), and undisturbed Soil Contamination Areas where a relatively low potential exists for the presence of removable contamination.

2. The determination as to the suitability of using precautionary clothing shall be based on a documented hazard analysis (for example, an HCP) for the facility, area, or operation. This analysis shall be performed by the environment- and safety-responsible line-management chain in consultation with ESH-1.
3. **Guidance Note:** Precautionary clothing typically consists of a fully buttoned lab coat with long sleeves or scrubs. Gloves appropriate for the operation may also be considered precautionary clothing in addition to the lab coat or scrubs. Facility-, area-, or operations-specific policy based on the hazard analysis may require a level of precautionary clothing up to and including level 1 protective clothing. A review of radiation incident reports (RIRs) and occurrence reports involving the contamination of individuals wearing precautionary clothing should be performed on a routine basis by the environment- and safety-responsible line-management chain to determine the necessity of upgrading the level of precautionary clothing currently in use.
4. HCPs, RWPs, or other work control documents shall specify the level of precautionary clothing required in the areas noted above in this article.
5. The requirements of Article 1425 (Monitoring for Personnel Contamination) shall apply to individuals exiting the above mentioned areas while wearing precautionary clothing. **Guidance Note**: It is recommended that a whole-body frisk, including the precautionary clothing, be performed. Facility-, area-, or operations-specific policy may require a whole-body frisk upon exiting these areas.
6. **Guidance Note**: Routine laundering of precautionary clothing should only be necessary for sanitary reasons. There is no requirement to launder this clothing at a nuclear laundry unless required by facility-, area-, or operations-specific policy.

Part 3 Respiratory Protection

Respiratory protective equipment shall include air-purifying respirators (APR) that are equipped with cartridges or canisters that remove particulates, gases, vapors, or a combination of the three; supplied-air respirators (SAR) that are pressure demand or continuous flow; self-contained breathing apparatus (SCBA); and powered air-purifying respirators (PAPR).

1031 General Provisions

1. Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source [see 29 CFR 1910.134].
2. Respirators shall be issued only to individuals who are medically qualified, trained, and fit-tested to wear the specific type of respirator. ESH-5 shall maintain the Laboratory's Respiratory Protection Program (ESH-5-RPP-R1). LIR402-1000-01, "Personal Protective Equipment," shall be referred to for further information and requirements regarding the Laboratory's respiratory protection program.

1032 Medical Assessment

Each prospective respirator wearer shall have a medical assessment by Occupational Medicine (ESH-2) before being fit-tested. The medical assessment shall determine if an employee's medical condition precludes the use of respirators and shall follow the guidance in ANSI Z88.6 on frequency and content of the examination [see 20 CFR 1910.134 and ANSI Z88.2]. The ability of an employee to accommodate the additional stress placed on the body when working in a respirator shall be part of this assessment.

1033 Using Respiratory Protection

Using respiratory protection devices can impair worker mobility and vision and cause discomfort and stress; thus, the issue and use of respiratory protective devices must be controlled.

1. **Guidance Note**: ESH-5 recommends that personnel using respirators do the following:
    a. Check the fit of tight-fitting respirators to ensure a proper seal before entering areas requiring respirator use.

b. Remove facial hair that will interfere with the fit of the respirator.

c. If you wear glasses, use corrective lenses (spectacle kits) that are approved for respirators by ESH-5.

d. Wear anti-c skull cap over respirator straps to prevent the skull cap from interfering with the respirator seal.

e. Make sure you are trained (facility- or operation-specific) to leave the work area when experiencing respirator failure.

f. Make sure you are trained to remove your respirator to avoid life-threatening situations when exiting an area after respirator failure.

2. The respirator protection factors (except for a protection factor of 100 rather than 50 for negative pressure, full-face-piece air-purifying respirators) and footnotes in Appendix A of 10 CFR Part 20 shall be used to select the required level of respiratory protection based on the airborne radionuclide concentrations and the anticipated duration of exposure. The committed effective dose equivalent (CEDE) and committed dose equivalent (CDE) received during the exposure combined with external and internal dose already received during the current year shall not exceed the dose limits specified in Table 4-1, chapter 4, and shall be ALARA.

Guidance Note: In some situations, because of a significant external dose rate field in the presence of airborne radioactivity, it may be necessary to optimize the TEDE rather than the CEDE or CDE. It may therefore be advantageous to allow the individual to receive a higher CEDE or CDE than would normally be allowed.

Appendix 10A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Personal Protective Equipment	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - The safety- and environment-responsible line-management chain, in conjunction with ESH-1, determines the radiological hazards and defines the PPE requirements sufficient to mitigate the radiological hazards. (Article 1021.1)
   - PPE is used only after other practical protection options have been applied. These other options include engineering measures such as containment, confinement, ventilation controls, shielding, sealing, filtration, and decontamination. (Article 1021.6)
   - Personnel wear protective clothing during the activities specified in Article 1022.1 and 1023.8.
   - Lab coats are used as protective clothing only under the circumstances described in Article 1022.2.
   - Individuals wearing shorts, skirts, dresses, or sandals do not enter areas controlled for contamination. (Article 1023.3)
   - Deviations from stated requirements in this chapter are documented and concurred with by the ESH-1 team leader. (Article 1023.13)
   - Respirators are issued only to those individuals who are medically qualified, trained, and fit-tested to wear the specific type of respirator required to perform the job. (Article 1031.2)
   - The minimum requirements for respiratory protection are implemented in accordance with Article 1033.2.

Work Planning

Contents

Work Planning

Appendix 11A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Planning Radiological Work

1111 Requirements

1. DOE regulations and requirements for occupational radiation protection and integrated safety management (ISM) require written authorizations that shall be implemented to control access to and work in radiological areas [see 835.501(d)].

   a. Authorization of workers to enter radiological areas must be handled through (1) a general or job-specific radiological work permit (RWP), (2) a hazard control plan (HCP), (3) a facility work control document, or (4) an equivalent work control document.

   b. Authorization of workers to work in radiological areas must be handled through (1) a general or job-specific RWP, (2) an HCP, (3) a facility work control document, or (4) an equivalent work control document.

   c. The level of detail included in such authorizations shall depend on facility hazards, the nature of the work force, and the activities to be performed during the entry.

2. The primary methods used to maintain exposures below regulatory limits and *as low as reasonably achievable* (ALARA) shall be facility and equipment design features [see 835.1001(a)]. **Guidance Note**: Performing certain activities, such as maintenance and modifications, may render permanently installed physical design features inadequate.

   A special subset of design features, often referred to as engineering controls (for example, temporary shielding, containment devices, and filtered ventilation systems) shall be used, as required, to control individual exposures. Design criteria that must be considered are discussed in chapter 12.

3. When physical design features, including engineering controls, are impractical or inadequate, they shall be augmented or replaced by administrative controls [see 835.1001(a) & (b)]. To accomplish this, the design and planning processes must incorporate radiological control considerations in the early planning stages.

4. The radiological hazard assessment and control process shall be integrated with the processes used to assess and control other workplace hazards. LIR300-00-01, "Safe Work Practices" describes the requirements that shall be implemented for performing hazards assessments and implementing associated controls for other than facility work. Facility hazard analysis and work controls shall be implemented through the requirements defined in LIR402-10-01, "Hazard Analysis and Control for Facility Work". An integrated set of controls for all hazards (for example, radiological, chemical, and physical) shall be developed and implemented from these hazard analyses. The worker must be made aware of all controls for these hazards, including all required permits and HCPs.

1112 Planning for Maintenance, Operations, and Modifications

1. **Guidance Note**: Routine or recurring process operations may incorporate standard radiation protection requirements and practices based on experience with existing conditions. Special radiological work (see the glossary, Attachment U, for definition) requires additional planning for the worker's radiological safety.
2. The following requirements shall be implemented for radiological work planning.

Who	Shall

Originator	• Identify work scope and whether work is radiological in nature.
	• With support of Health Physics Operations (ESH-1), decide
	  • when the radiological work is to be performed.,
	  • whether the radiological work is routine or special, and
	  • what areas are to be entered.
	• Determine the need for additional ES&H review based on other hazards besides ionizing radiation.
	• Review and approve work plans that provide a clear set of safety expectations for work and workers.

ESH-1	Identify special instructions and protective measures required for the safe completion of work.
Safety- and environment-responsible line-management chain	• In conjunction with ESH-1, identify radiological conditions and hazards associated with the work activity. • In conjunction with ESH-1, incorporate the special instructions and protective measures required for the safe completion of work into work plans and communicate them to the radiological workers before the start of work. • Review and approve the work plans to ensure that radiological hazards and controls are addressed. • In conjunction with ESH-1, review the dose histories of the workers to prevent them from exceeding administrative dose limits, Laboratory performance goals, and regulatory dose limits. • In conjunction with ESH-1, ensure that personal protective equipment and monitoring devices are provided to and used by radiological workers. • Communicate to the worker for each radiological task to be performed (typically defined by a RWP or HCP) what protective measures must be taken and where those protective measures are stated.
Radiological workers	• Understand, unequivocally, which work control documents cover which specific tasks for a series of tasks to be performed over any time period (for example, daily shift). • Follow the requirements of the work control documents. • Comply with work controls. • Stop work when controls are not adequate for current and potential hazards.

1113 Radiological Work Control Documents

1. Radiological work control documents shall include HCPs and RWPs. The type of work control document to be used shall be based on the complexity and importance of the work and the potential for worker exposure to radiological hazards. Work control documents must be readily accessible to the worker and must be based on the education, training, and level of skill of the workers using them [see 835.104].
2. **Guidance Note**: Routine radiological work (see the glossary for definition) may be performed using HCPs (except in certain areas and/or certain conditions as noted below) or general RWPs.

If an HCP is used it shall include the same standard radiation protection requirements and information as those specified in the RWP (see Article 1131.1, this chapter). HCPs addressing radiological hazards and controls shall be developed, reviewed, and approved in accordance with LIR300-00-01, "Safe Work Practices," and LIR300-00-02, "Documentation of Safe Work Practices."

3. When work plans call for the use of an RWP in controlling radiological work, the plans, including the RWP, shall be reviewed and approved by ESH-1.

4. Work plans that involve routine or special radiological work in the following areas or for the following conditions shall require an RWP:

   a. High or Very High Radiation Area,

   b. High Contamination Area,

   c. Airborne Radioactivity Area, or

   d. when an HCP cannot reasonably address radiological conditions (for example, significantly changing radiological conditions)

5. Formal ALARA reviews shall be conducted for special radiological work that has the potential to equal or exceed the trigger levels established in Appendix 3B of chapter 3. The formal ALARA review process shall consist of three parts:
   a. pre-job planning and dose estimation;
   b. implementation of ALARA control measures (such as those found in the ALARA Review Checklist, Appendix 3C of chapter 3) and dose-tracking; and
   c. post-job review (see Article 1933, chapter 19).

6. ALARA reviews for routine radiological work shall be performed through the normal RWP or HCP process. Formal ALARA reviews shall not be required for routine radiological work that has the potential to equal or exceed the trigger levels established in Appendix 3B, chapter 3.

7. The radiation protection organization, the safety- and environment-responsible line-management chain, and any other organization having responsibilities for implementing the Laboratory's Radiation Protection Program shall write procedures as required to implement the requirements defined in this LIR that are derived from 10 CFR 835 [see 835.104]. These procedures shall be commensurate with the radiological hazards created by the activity and the education, training, and skills of the individuals who will be exposed to these hazards [see 835.104].

8. Care shall be exercised to ensure that documents generated in response to the requirements of this chapter are not classified, or are properly; reviewed, marked, and protected. If the work involves a classified activity or project, the work control document must be either unclassified or properly received, marked , and handled.

Part 2 Work Preparation

1121 Radiological Work Permits (RWP)

The RWP (sometimes known as a *radiation work permit*) shall be the administrative mechanism used to establish radiological controls for intended work activities, authorize radiological work, and authorize radiological workers. The RWP shall inform workers of area radiological conditions and entry requirements and provide a mechanism to relate worker exposure to specific work activities.

1. The following information shall be included in an RWP, an HCP, or other work control document that substitutes for an RWP:

   a. description of the work;

   b. work area radiological conditions;

c. dosimetry requirements;

d. pre-job briefing requirements;

e. training requirements for entry;

f. protective equipment and respiratory protection requirements;

g. RCT coverage requirements and stay-time controls;

h. limiting radiological conditions that may void the RWP;

i. special dose or contamination reduction considerations;

j. unique identifying number;

k. technical work document number;

l. date of issue and expiration;

m. authorizing signatures for the work to proceed by ESH-1 (except for HCPs or other work control documents that don't require ESH-1 authorization signatures), the operating group, or the subcontractor, as required for the work activities covered by the RWP; and

n. authorizing signatures by the safety- and environment-responsible line-management chain (for example, group leader).

2. The RWP shall be based on current radiological surveys and anticipated radiological conditions.

3. **Guidance Note**: General RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with well-characterized and stable radiological conditions.

   General RWPs shall not be approved for periods longer than one year and shall be filed in the year initiated. General RWPs shall be subject to revision based on radiological conditions that change to the extent that the controls would require modification. Job-specific RWPs shall be reviewed, are not to exceed a period of three months, and shall remain in effect only for the duration of the specific work. The three-month period shall be extended only after a review is completed.

4. The RWP shall be used to provide an ALARA review and establish radiological controls for intended work activities. The RWP shall inform workers of ALARA requirements.

5. A job-specific RWP shall be used for special radiological work.

6. 10 CFR 835 requires that records of actions taken to keep doses ALARA be maintained; therefore, if pre-job briefings are used for ALARA purposes, records of the briefings shall be maintained [see 835.704(b)].

7. RWPs shall authorize work specific to radiological hazards only. If other hazards exist, permits and/or HCPs addressing these other hazards must be obtained for the work to proceed.

1122 Implementing the Radiological Work Planning Process

1. The radiological work plans shall follow the five-step approach to working safely (refer to LIR300-00-01.0 "Safe Work Practices," for nonfacility work and LIR402-10-01, "Hazard Analysis and Control for Facility Work," for facility work). All workers must follow work control documents and their radiological work controls.

2. The safety- and environment-responsible line-management chain, employees, contractors, and visitors must follow Radiation Protection Program requirements contained in work control documents.

3. Attendees at the pre-job briefings shall include the work group supervisor the workers, and any other personnel supporting the work.

4. Workers shall sign on the RWP pre-job briefing log that they have read, understood, and will implement the RWP requirements before initial entry to the area and after any revisions to the RWP. Workers shall

implement these work instructions and radiation protection measures to ensure safe completion of the job. If workers identify safety issues not covered by the RWP, they shall immediately identify these concerns to ESH-1 and their work group supervisor for resolution.

5. The safety- and environment-responsible line-management chain and required ESH-1 personnel shall approve the RWP. Revisions or extensions to RWPs shall be subject to the same approval process.

6. Radiological surveys shall be routinely performed by ESH-1 and reviewed to evaluate the adequacy of RWP requirements. RWPs shall be updated if radiological conditions change to the extent that the "ALARA/Radiological Protection Requirements" or "Hold Points/Special Instructions" sections of the RWP require modification.

7. Work plans that require authorizations, signatures, and RWPs/HCPs shall be maintained according to the radiation protection records program requirements of chapter 20.

1123 Work Conduct and Practices

1. Engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, shall be installed in accordance with the work control documents and inspected before use.

2. Prerequisite conditions, such as tag-outs and system isolation, shall be verified in accordance with the technical work documents before work is initiated.

3. The identity of components and systems shall be verified before work is initiated.

4. Upon identification of radiological concerns, such as incorrect work controls or procedural deficiencies, workers shall immediately report the concern to the safety- and environment-responsible line-management chain and ESH-1. If required to control individual exposure to radiological hazards, the affected individuals shall exit the area until these issues are resolved and required controls have been instituted.

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ESH-1 USE ONLY
Permit Number _____
Effective _____ Expires ____

Radiological Work Permit

GENERAL INFORMATION (to be completed by requester)

Requested by: (*printed name, signature)*	Group	Phone No.	Mail Stop	Work Location (TA, Bldg, Room No.)

HCP No.	Small Job Ticket No.	Work Order No.	SWP No.	Requested Start Date	Expected End Date

Work to be performed:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Are nonradiological hazards involved? Yes ❑ No ❑ If yes, the nonradiological hazards must be covered by an appropriate permit, HCP, or other work control document.

PRE-JOB RADIOLOGICAL CONDITIONS (to be completed by RCT/HPT)

❑ Anticipated radiological conditions (enter anticipated conditions if survey cannot be performed before work begins) **or**

❑ Measured radiological conditions *(Record all readings as highest/general area.)* ❑ See attached map

Surface Contamination (dpm/100 cm^2)

	Direct	Smear	LAS (large area swipe)
Alpha	_____/_____	_____/_____	_____/_____
Beta/gamma	_____/_____	_____/_____	_____/_____
Tritium		_____/_____	

External Dose Rate
(mrem/hr in work area)

Beta + gamma _____/_____
Neutron _____/_____
Total ($\beta + \gamma + n$) _____/_____

Identify anticipated radionuclides:

Airborne Radioactivity
_____ DAC_____ Isotope
❑ Expected **or** ❑ Measured

Identify any contamination under paint or on inaccessible surfaces:

Completed by RCT/HPT *(printed name)*	Signature	Z Number	Date

ALARA/RADIOLOGICAL PROTECTION REQUIREMENTS (to be completed by RCT)

Protective Clothing Requirements ❑ None ❑ Level I (Coveralls, 2 pair anti-c gloves, and booties)
❑ Lab coat ❑ Skull cap ❑ Hood ❑ Taped openings ❑ Level II (2 coveralls, 2 pair anti-c gloves, 2 pair booties)
❑ Anti-C Gloves ❑ Booties ❑ Other: _____

Respiratory Requirements ❑ None ❑ ESH-5 respirator card ❑ Supplied air mask* ❑ SCBA*
❑ Full-face respirator ❑ Ventilation ❑ Combination cartridge* ❑ Supplied air suit*
❑ Particulate cartridge ❑ Job-specific air monitoring ❑ Chemical cartridge*
❑ Other: _____ **Requires ESH-5/JSFT (JCNMM) approval*

Dosimetry Requirements ❑ None ❑ WB dosimeter ❑ Supplemental dosimeter ❑ Alarming dosimeter
❑ Extremity dosimeter ❑ Special neutron dosimetry ❑ PNAD packet ❑ Pu access list ❑ Nasal swipes
❑ Special urinalysis ❑ Whole-body count ❑ Other: _____

Monitoring Requirements ❑ None ❑ Notify RCT before job starts @ _____ ❑ Notify RCT at job end
❑ Intermittent coverage ❑ Personnel before leaving job ❑ Equipment and tools before removal
❑ Self-frisking ❑ Continuous coverage ❑ RCT monitor doffing of anti-Cs
❑ Other: _____

Training Requirements ❑ RW I ❑ RW II ❑ Other: _____

ALARA Requirements
ALARA Review Checklist attached: ❑ Yes ❑ No
❑ Routine work ❑ Special radiological work
Estimated person-hours for job _____
Estimated /measured working dose rates _____
Estimated collective dose _____person-rem

HOLD POINTS/SPECIAL INSTRUCTIONS (to be completed by RCT)

Hold Points or Special Instructions (for example, individual dose limits, collective dose limits, contamination limits, etc.):

_____
_____
_____
_____
_____
_____
_____
_____

Completed by RCT *(printed name)*	Signature	Z Number	Date

APPROVALS

1. Manager	Signature	Z Number	Date
2. RCT supervisor	Signature	Z Number	Date
3. Other *(job title/printed name)*	Signature	Z Number	Date
4. Other *(job title/printed name)*	Signature	Z Number	Date

POST-JOB RADIOLOGICAL CONDITIONS (to be completed by RCT/HPT)

Measured Radiological Conditions *(Record all readings as highest/general area.)* ❑ See attached map

Surface Contamination (dpm/100 cm^2)			External Dose Rate (mrem/hr in work area)	
	Direct	Smear	LAS (large area swipe)	
Alpha	_____/_____	_____/_____	_____/_____	Beta + gamma _____/_____
Beta/gamma	_____/_____	_____/_____	_____/_____	Neutron _____/_____
Tritium		_____/_____		Total ($\beta + \gamma + n$) _____/_____

Airborne Radioactivity _____ DAC _____ Isotope ❑ Estimated **or** ❑ Measured

Completed by RCT/HPT *(printed name)*	Signature	Z Number	Date

REVIEW

Associated reports for this job *(indicate the ones that apply)*:

❑ CAM results	❑ Nasal swipe data	❑ Dose tracking report
❑ Job-specific air monitoring	❑ Urinalysis report	❑ Radiological occurrence/incident report
❑ Pre-job survey data	❑ Whole-body count	❑ Changes in radiological protection requirements
❑ Post-job survey data	❑ Wound count	❑ Pre-job briefing log
❑ Extremity dose data	❑ Skin contamination	❑ ALARA Review Checklist
❑ Special dosimetry results	❑ Personal clothing survey	❑ Other: _____

Lessons learned? ❑ Yes (*Add attachment if necessary*) ❑ No

ALARA actions taken and results:

Problems encountered:

Recommendations for future similar jobs:

Reviewed by RCT *(printed name)*	Signature	Z Number	Date
Reviewed by RCT supervisor *(printed name)*	Signature	Z Number	Date

INSTRUCTIONS FOR COMPLETING THE RWP FORM

General Information (to be completed by requester)

1. Enter your printed name and signature, group number or organization, telephone number, and mail stop.
2. Enter the work location (technical area, building, and room number).
3. Enter any SOP (safe operating procedure), SJT (small job ticket), or WO (work order) number the RWP will support. Enter NA in any blocks that do not apply.
4. Enter the requested start date and the expected end date.
5. Describe the work to be performed. (Add attachment if necessary. Include enough detail for the RCT to determine the extent of survey needed, radiological protection requirements, and anticipated changes in radiological conditions.)
6. Complete and attach to the RWP a copy of the SJT ES&H Review or a copy of the ES&H Review Service Request/Supplement.
7. Ensure that the RWP is sent to the appropriate RCT or RCT supervisor.

ESH-1 Use Only (to be completed by RCT/HPT or RCT supervisor)

1. Enter the effective date and expiration date after you have read the GENERAL INFORMATION block.
2. Obtain a permit number from your team or field office and enter it in the top block and inform the team or field office of the effective date and expiration date for the RWP.

Pre-Job Radiological Conditions (to be completed by RCT/HPT)

1. Check the box indicating whether the radiological conditions are anticipated or measured. (Conditions inside ducts or pipes typically cannot be measured before breaching those systems. Conditions inside a locked room typically would be measured before work starts in that room.)
2. Indicate whether survey data are shown on an attached map.
3. Enter the survey data to support the RWP. The most recent survey of the area can be used if conditions in that area would remain unchanged. If a survey cannot be performed before the RWP is approved, then estimate the radiological conditions. (A survey must still be performed before the work can start.)
4. Identify radionuclides if possible.
5. Enter data for airborne radioactivity and check box indicating whether data are anticipated or measured.
6. Identify any contamination under paint or on inaccessible surfaces.
7. Mark NA in any blocks that do not apply.
8. Enter your printed name, signature, Z number, and the date.

ALARA/Radiological Protection Requirements (to be completed by RCT)

Indicate Radiological Protection Requirements by checking the appropriate boxes. Use the requirements and guidance specified in the applicable documents (for example, ALARA Review Checklist). Specify whether the work is “routine” or “special.” Complete the ALARA Review Checklist if required.

Hold Points/Special Instructions (to be completed by RCT)

1. Indicate any hold points, such as when work must be halted to allow additional surveys or to allow radiological conditions to stabilize. Indicate any special instructions that need to be communicated to the workers (for example, ALARA measures, special work measures)
2. Enter your printed name, signature, Z number, and the date.

Approvals (to be completed by the safety- and environment-responsible line-management chain, RCT supervisor, and other personnel as required)

1. Enter your signature, Z number, group or organization, and the date.

Post-Job Radiological Conditions (to be completed by RCT/HPT)

1. Enter the post-job radiological survey data.
2. Indicate whether survey data are shown on an attached map.
3. Enter data for airborne radioactivity and check box indicating whether data were estimated or measured.
4. Enter your printed name, signature, Z number, and the date.

Review (to be completed by RCT and RCT supervisor)

1. Indicate all associated reports for the RWP by checking the appropriate boxes. (Do not wait to receive the reports before reviewing the RWP.)
2. Indicate if there are “lessons learned” to be conveyed to others. If Yes is checked, briefly explain.
3. Jointly review the RWP for completeness and correctness.
4. Enter your printed name, signature, Z number, and the date.

Los Alamos Pre-Job Briefing Log

National Laboratory

RWP Number	Change Number	Location

By signing this log, I acknowledge that I have read the radiological conditions and protection requirements and attended a pre-job briefing on the RWP. I understand these conditions and protection requirements and will abide by them.

Z Number	Name (*print*)	Organization	Name (*signature*)	Date	Time
Conducted by:			Date:		

Consider the following topics and check the boxes, as appropriate. (To be completed by RCT)

❑ Scope of work to be performed

❑ Radiological conditions of the workplace

❑ Procedural and RWP requirements

❑ Special radiological control requirements

❑ Radiologically limiting conditions, such as contamination or radiation levels that may void the RWP

❑ Radiological control hold points

❑ Communications and coordination with other organizations

❑ Provisions for housekeeping and final cleanup

❑ Emergency response provisions

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Changes to the RWP
(to be completed by the RCT)

RWP Number: **Change Number:**

State reason for changes (such as changes in radiological conditions, scope, or type of work)

ALARA/RADIOLOGICAL PROTECTION REQUIREMENTS (to be completed by RCT)

Protective Clothing Requirements ❑ None ❑ Level I (Coveralls, 2 pair anti-c gloves, and booties)
❑ Lab coat ❑ Skull cap ❑ Hood ❑ Taped openings ❑ Level II (2 coveralls, 2 pair anti-c gloves, 2 pair booties)
❑ Anti-C Gloves ❑ Booties ❑ Other: _____

Respiratory Requirements ❑ None ❑ ESH-5 respirator card ❑ Supplied air mask* ❑ SCBA*
❑ Full-face respirator ❑ Ventilation ❑ Combination cartridge* ❑ Supplied air suit*
❑ Particulate cartridge ❑ Job-specific air monitoring ❑ Chemical cartridge*
❑ Other: _____ **Requires ESH-5/JSFT (JCNNM) approval*

Dosimetry Requirements ❑ None ❑ WB dosimeter ❑ Supplemental dosimeter ❑ Alarming dosimeter
❑ Extremity dosimeter ❑ Special neutron dosimetry ❑ PNAD packet ❑ Pu access list ❑ Nasal swipes
❑ Special urinalysis ❑ Whole-body count ❑ Other: _____

Monitoring Requirements ❑ None ❑ Notify RCT before job starts @ _____ ❑ Notify RCT at job end
❑ Intermittent coverage ❑ Personnel before leaving job ❑ Equipment and tools before removal
❑ Self-frisking ❑ Continuous coverage ❑ RCT monitor doffing of anti-Cs
❑ Other: _____

Training Requirements ❑ RW I ❑ RW II ❑ Other: _____

ALARA Requirements Estimated person-hours for job _____
ALARA Review Checklist Estimated /measured working dose rates _____
attached: ❑ yes ❑ no Estimated collective dose _____ person-rem
❑ Routine work ❑ Special radiological work

UPDATED RADIOLOGICAL CONDITIONS (to be completed by the RCT)

Measured Radiological Conditions *(Record all readings as highest/general area.)* ❑ See attached map

Surface Contamination (dpm/100 cm^2)

	Direct	Smear	LAS (large area swipe)
Alpha	_____/_____	_____/_____	_____/_____
Beta/gamma	_____/_____	_____/_____	_____/_____
Tritium		_____/_____	

External Dose Rate (mrem/hr in work area)

Beta + gamma	_____/_____
Neutron	_____/_____
Total ($\beta + \gamma + n$)	_____/_____

Airborne Radioactivity _____ DAC_____ Isotope ❑ Estimated **or** ❑ Measured

Completed by RCT/HPT *(printed name)*	Signature	Z Number	Date

APPROVALS (requires same level of approval as original RWP)

1. Manager	Signature	Z Number	Date
2. RCT supervisor	Signature	Z Number	Date
3. Other *(job title/printed name)*	Signature	Z Number	Date
4. Other *(job title/printed name)*	Signature	Z Number	Date

Instructions for Completing the RWP Change Form

ALARA/Radiological Protection Requirements (to be completed by the RCT)

1. Use the change form for different phases of the work activity, different crafts, or changes in radiological conditions. The change form may be initiated at the start of a job, such as when it is known that different crafts need different radiological protection requirements. Major changes in work scope or radiological conditions require that a new RWP be completed.
2. State the reason for the changes (such as changes in radiological conditions or scope or type of work).
3. Complete according to the instructions on the RWP form.
4. Complete ALARA Review Checklist if required.

Appendix 11A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Work Planning	LIR400-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information.*

   - The radiological hazard assessment and control process is integrated with processes to assess and control other workplace hazards. (Article 1111.4)
   - The worker is aware of controls for all hazards, including all applicable permits and HCPs, for the job, not just those for radiological hazards. (Article 1111.4)
   - The safety- and environment-responsible line-management chain, in conjunction with ESH-1, identifies radiological conditions and hazards associated with the work activity, and ESH-1 identifies special instructions and protective measures. (Article 1112)
   - Special instructions and protective measures are incorporated into work plans and are communicated to workers before the work begins. (Article 1112)
   - RWPs are used for routine or special radiological work in High or Very High Radiation Areas, High Contamination Areas, and Airborne Radioactivity Areas; or when an HCP cannot reasonably address radiological conditions. (Article 1113.4)
   - Radiological work plans and RWPs are reviewed and approved by ESH-1. (Article 1113.3)
   - RWPs, HCPs, or other work control documents contain the information listed in Article 1121.1.
   - General RWPs are used to control routine or repetitive activities and are in effect for no longer than one year. (Article 1121.3)
   - Job-specific RWPs are not to exceed 3 months (unless extended following a review) and remain in effect only for the duration of the specific work. (Article 1121.3)
   - Radiological work plans follow the five-step approach to working safely. (Article 1122.1)
   - Workers sign on the RWP pre-job briefing log that they have read, understood, and will comply with the RWP before initial entry to the area and after any revisions to the RWP. The workers are knowledgeable about the conditions of the area and requirements of the RWP. (Article 1122.4)

Radiological Design and Control

Contents

Radiological Design and Control

Appendix 12A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1211 General Requirements

Who	Shall
Division directors, program directors, or office directors	Ensure that projects or facilities under their control receive radiological engineering design at the earliest possible time in the design and a radiological engineering and operational review of the designs before actual construction or modification begins.
The facility manager or the safety- and environment-responsible line-management chain	Provide information to the ESH-12 (Radiation Protection Services) Radiological Engineering Team and Health Physics Operations (ESH-1) on planned radiological designs or modifications in the facility.
Radiological workers	Notify their supervisors of any changes that might affect the radiological control program at their facility.
ESH-1	• Provide radiological monitoring data to ESH-12 as requested. • Perform radiological design reviews of engineering designs and perform *as low as reasonably achievable* (ALARA) design reviews if required.
The design project management team	Notify the ESH-12 Radiological Engineering Team of new facilities or modification of facilities meeting the requirements specified in this chapter.
ESH-12	Perform radiological design reviews of engineering designs and perform *as low as reasonably achievable* (ALARA) design reviews if required.

Part 2 Design and Control Requirements

1221 Radiological Design Criteria

The following design objectives and requirements shall apply during the design of new facilities and modification of existing facilities.

1. Measures shall be taken to maintain radiation exposure in controlled areas ALARA through physical design features and administrative control.

   a. The primary methods used shall be physical features (for example, confinement, ventilation, remote handling, and shielding).

   b. Administrative controls shall be employed only as supplemental methods to control radiation exposure. (See 1231 of this document, Control Procedures.)

   c. For specific radiological activities in which physical design features are demonstrated to be impractical, administrative controls shall be used to maintain radiation exposure ALARA.

2. For areas that are continuously occupied by radiological workers (2000 hours per year), the design objective shall be to maintain the radiation exposure level ALARA and below an average of 0.5 millirem per hour. The design objective shall be to maintain doses ALARA and below 20% of the occupational dose limits provided in Table 4-1 [see 835.1002(b)]. **Guidance Note**: For areas occupied by general employees and members of the public (not radiological workers), the design objective should be to maintain the average exposure level

ALARA and below 0.1 rem (1 mSv) per year by virtue of physical and/or administrative controls. Continuous occupancy (2000 hours per year) should be assumed unless the occupancy for the area has been well established.

3. For control of airborne radioactivity, the design objective shall be to avoid releases to the work place atmosphere under normal conditions and, under any conditions, to control inhalation by workers to levels that are ALARA. Confinement and ventilation shall normally be used [see 835.1002(c)].
4. For materials used in facility construction and modification, the design objective shall be to select materials that facilitate operations, maintenance, decontamination, and decommissioning [see 835.1002(d)].
5. In justifying facility design and physical controls, optimization methods, as discussed in International Commission on Radiological Protection (ICRP) Publication 37 and 55, shall be used [see 835.1002(a)].
6. Radiological surveys shall be performed during start-up through full operations to ensure that established design objectives have been met for modifications of existing facilities and designs of new facilities. If survey data indicate that the established design objectives have not been met after reasonable personnel occupancy factors have been applied, then compensatory measures must be implemented (that is, physical and/or administrative controls).
7. The required radiological design criteria and practices shall be incorporated into modifications of existing facilities and designs of new facilities as early as possible in the engineering and design process.
8. Support areas shall be provided for donning and doffing protective clothing and for personnel monitoring when required.
9. Material, including components of systems, shall be selected to minimize the neutron or particle activation of the materials in the vicinity of the radiological operation. In addition, materials shall be selected, and the design optimized, to minimize the buildup of radioactive materials.
10. When a new facility or modifications to an existing facility are planned, the design project management team shall notify and coordinate with the ESH-12 Radiological Engineering Team for radiological engineering design support and/or review of the project design.
11. A formal radiological engineering analysis and design review shall be required if any of the following conditions or facility types is expected to prevail, or if one of these conditions is expected to be present later in the life of the facility.
    a. Dose rates exceed 0.5 mrem/hour at 30 cm or more from any surface in the facility or areas occupied by radiological workers during routine operation.
    b. A reasonable potential for inhaling airborne radioactive material in the facility during routine operation is present.
    c. A reasonable potential for contamination exceeding Table 14-1, chapter 14, contamination values in the facility during routine operation is present.
    d. A reasonable potential for public or nonradiological worker exposure during routine operation is present.
    e. The facility is defined as any of the following:
        - plutonium processing and handling facilities
        - plutonium storage facilities
        - unirradiated enriched uranium storage facilities
        - explosives facilities (using radioactive materials)
        - uranium enrichment facilities
        - uranium processing and handling facilities
        - irradiated fissile material storage facilities

- reprocessing facilities
- uranium conversion and recovery facilities
- radioactive liquid waste facilities
- radioactive solid waste facilities
- laboratory facilities (using radioactive material in hot cells, glove boxes, hoods, or similar enclosures)
- accelerators
- x-ray devices capable of generating a dose rate of >150 rads/minute (1.5 grays/minute) at 1 meter
- tritium facilities
- fusion test facilities

12. **Guidance Note**: For analyzing design basis accidents, the following dose guidelines should be used:

Annual Frequency	Offsite (dose in TEDE)	Onsite (dose in TEDE)
< 0.1 but 0.01 events per year	5 rem (0.05 sievert)	5 rem (0.05 sievert)
< 1 E-02 but 1 E-04 events per year	5 rem (0.05 sievert)	25 rem (0.25 sievert)
< 1 E-04 but 1 E-06 events per year	25 rem (0.25 sievert)	100 rem (1 sievert)

TEDE: Total Effective Dose Equivalent

13. To document the radiological review, the ESH-12 Radiological Engineering Team shall complete a review record for facilities engineering design.

14. Care shall be exercised to ensure that documents generated in response to the requirements of this chapter are not classified, or are properly reviewed, marked, and protected. If the review involves a classified activity or project, the documents generated in response to the requirements of this LIR must be either unclassified, or properly received, marked , and handled.

Part 3 Control Requirements

1231 Control Procedures

1. Administrative control and procedural requirements shall be developed and implemented as required to supplement facility design features, particularly when existing facilities have not been designed in accordance with current standards [see 835.1001(b)]. Administrative control procedures shall include access control measures, radiological work permits (RWPs), or other work control documents.

2. The combination of design features and administrative control procedures shall be enough to ensure that, during routine operation, the Table 4-1, chapter 4, dose limits for each type of worker shall be met and the doses are ALARA [see 835.1003(a)].

Appendix 12A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radiological Design and Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - The radiological design criteria specified in Article 1221.1 through 1221.5 are used in designing new and modified facilities.
   - Appropriate radiological design criteria and practices are incorporated into modifications of existing facilities and design of new facilities as early as possible in the engineering and design process. (Article 1221.7)
   - Components that minimize the build-up of particle- and neutron-activated radioactive materials are used where appropriate. In addition, materials are selected and the design is optimized to minimize the buildup of radioactive materials. (Article 1221.9)
   - The design project management team notifies and coordinates with the ESH-12 Radiological Engineering Team for radiological engineering design support and/or review of the project design. (Article 1221.10)
   - A formal radiological engineering design review is performed if any of the conditions or facilities listed in Article 1221.11 are expected.
   - The combination of design features and administrative control procedures are sufficient to ensure that during routine operations, the dose limits in Table 4-1 have been met for the appropriate type of worker and that the doses are ALARA. (Article 1231.2)

Radiation Protection Instrumentation

Contents

Radiation Protection Instrumentation

Appendix 13A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1311 General Requirements

Who	Shall
The division director, program director, or office director	Ensure that required instrumentation is available.
The safety- and environment-responsible line-management chain	Ensure that individuals who use radiation detection instruments for radiation protection purposes implement the requirements of this attachment.
The Health Physics Operations (ESH-1) RCT or other qualified and authorized individual	• Use radiation detection instruments in accordance with established procedures. • Ensure that radiation detection instruments used for radiation protection purposes are returned for calibration when they are due.
The Health Physics Measurements (ESH-4) Radiation Instrumentation and Calibration Team (RIC)	• Calibrate, maintain, and repair radiation detection instruments used for radiation protection. • Maintain records of these activities in accordance with chapter 20 of this LIR. • Test instruments to determine their suitability for the specific types, levels, and energies of the radiation and environmental conditions that may be encountered in the field.

Part 2 Radiation Protection Instrumentation and Calibration Requirements

1321 Calibration and Operability Tests

1. Radiation protection instruments shall be registered with ESH-4 RIC before first use.
2. ESH-4 RIC shall calibrate instrumentation used for radiation protection purposes by using radiation sources and other devices whose accuracy and strength can be directly traced to the National Institute of Standards and Technology (NIST) or an international equivalent that provides radiation energies similar to those that may be encountered during use.
3. ESH-4 RIC shall calibrate instrumentation covered in this chapter (including pocket and electronic dosimeters, and area radiation monitors) as shown below:
   a. before it is first used,
   b. after repair or maintenance (other than battery change-out),
   c. when an operability check by a qualified operator fails,
   d. when readings are suspect, and
   e. at least annually [see 835.401(b)(1)].

4. Instruments used to measure other physical quantities (for example, flow and volume) shall be maintained and calibrated using required standards on at least an annual basis by ESA-MT and the support service contractor.

5. The user shall identify defective, damaged, or out-of-tolerance instruments and equipment, as well as instruments that are beyond their calibration date, and remove them from service immediately. The user shall return these items to ESH-4 RIC for repair and recalibration as required. Before returning them to ESH-4 RIC, instruments and equipment must be surveyed and released in accordance with Article 1432 or 1433, chapter 14, depending on where the instrument or equipment will be sent (that is, to ESH-4 RIC or off the site).

6. The following requirements shall apply to all radiation detection instruments used for radiation protection purposes.

   a. Only trained and qualified personnel shall perform operations and interpret results using ESH-1 procedures for operability checks of instruments and health physics measurements in the field.

   b. The effects of environmental conditions, including interfering radiation, on an instrument shall be known and accounted for before the instrument is used [see 835.401(b)(3)].

   c. Instruments used for monitoring and contamination control shall be routinely tested for operability in accordance with ESH-1 instrument procedures.

   d. ESH-4 RIC shall implement a quality control program to maintain, calibrate, and repair health physics instruments.

   e. Instrument maintenance shall be conducted consistent with the calibration cycle [see 835.401(b)(1)].

   f. Instruments shall be those required for the type(s), levels, and energies of the radiation that will be encountered.

   g. Workplace instruments shall be capable of measuring ambient radiation dose rates.

   h. Radiation detection instruments shall be used only to measure the radiation for which their calibrations are valid [see 835.401(b)(2)].

7. ESH-4 RIC shall develop technical basis documents that outline the environmental parameters for using the instrument. The technical basis documents shall also outline instrument response according to type, level, and energies of radiation encountered.

8. Sufficient quantities of dose rate meters, counting instruments, and contamination monitoring equipment shall be available to ensure that all requirements in this LIR can be met.

9. ESH-4 shall standardize radiation protection instruments that have been tested and approved for use at Los Alamos. Procuring radiation protection instruments must be coordinated with the ESH-4 RIC so that the RIC can ensure the instruments will be tested in accordance with Article 1311.

10. ESH-4 RIC shall notify users when calibration is due for instruments that are registered in its database.

Appendix 13A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radiation Protection Instrumentation	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information.*

   - Radiation detection instruments used for radiation protection purposes are returned to the ESH-4 RIC for calibration when they are due. (Article 1311)
   - The ESH-4 RIC calibrates radiation detection instruments used for radiation protection purposes using radiation sources and other devices to which the accuracy and strength can be directly traced to recognized standards (that is, NIST or other equivalent). (Article 1321.2)
   - The ESH-4 RIC annually calibrates radiation detection instruments used for radiation protection purposes as required in Article 1321.3.
   - Only trained and qualified personnel perform operations and interpret results using ESH-1 procedures for operability checks of instruments and health physics measurements in the field. (Article 1321.6.a)
   - The effects of environmental conditions, including interfering radiation, on radiation detection instruments used for radiation protection purposes are known and accounted for before they are used. (Article 1321.6.b)
   - Radiation detection instruments used for radiation protection purposes are routinely tested for operability. (Article 1321.6.c.)
   - Radiation detection instruments used for radiation protection purposes are appropriate for the types, levels, and energies of the radiation encountered in the field. (Article 1321.6.f.)

Contamination Control

Contents

Contamination Control

Appendix 14A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1411 General Requirements

Who	Shall
Safety- and environment-responsible line-management chain	• Verify that administrative and physical controls are implemented to control the transfer of removable contamination to locations outside radiological areas and outside Radiological Controlled Areas (RCAs) under normal operating conditions. • Implement administrative and physical controls in the workplace to prevent the inadvertent release of contaminated materials, equipment, and personnel. • Direct decontamination efforts.
Radiological workers	• Review the radiological conditions and associated hazards in the work area, according to the work control processes in place. • Review and implement the contamination control program for the area. • Notify immediate supervisor of any changes in process or loss of control of radioactive material that might affect the contamination control program in the work area. • Contact a radiological control technician (RCT) to survey materials and equipment before releasing them from an RCA. • Provide knowledge-of-process information to Health Physics Operations (ESH-1) personnel. • Perform decontamination activities in accordance with the level of training received. • Receive training and qualification as a radiological worker (RW).
ESH-1 or other trained and qualified personnel	• Provide radiological monitoring of areas, materials, equipment, and personnel. • Assist in contamination control.
Health Physics Measurements (ESH-4)	• Analyze radiological samples. • Maintain and calibrate radiological survey and monitoring instruments.

Part 2 Contamination Control Requirements

1421 Contamination Control Levels

A surface shall be considered contaminated if either the removable or total surface contamination is detected at levels above those specified in Table 14-1 in this chapter. Controls shall be implemented for these surfaces commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable surface contamination levels [see 835.1102(b)]. Postings and controls shall be implemented as specified in chapters 7, 9, and 11 of this LIR.

1422 Airborne Radioactivity Control Levels

Posting requirements for accessible areas with airborne radioactivity shall be implemented as specified in Article 725, chapter 7. Values of derived air concentrations (DACs) shall be those provided in Appendixes A and C of 10 CFR 835. **Guidance Note**: ESH-1 team leaders and managers may modify the Appendix C DACs to account for submersion in a cloud of finite dimensions [see 835, Appendix C, note b].

1423 Areas of Fixed Contamination

Guidance Note: Because of reduced concern regarding the spread of fixed contamination, areas having only fixed contamination may not warrant the full range of entry controls established for areas having removable contamination levels that are at or below the levels specified in Table 14-1, this chapter.

Areas located outside radiological areas that have measured total contamination exceeding the total surface contamination values specified in Table 14-1 (removable contamination levels below Table 14-1 values) shall be subject to the following controls:

1. Periodic surveys as specified in ESH-1 routine monitoring instructions (RMIs) shall be conducted to ensure that surface contamination remains fixed to the surface and removable surface contamination levels remain below Table 14-1 values [see 835.1102(c)(1)].
2. Areas shall be marked to warn individuals of their fixed contamination status [see 835.1102(c)(2)].
3. Areas meeting these requirements shall be exempt from the posting requirements of Article 725, chapter 7, and the entry and exit requirements of Article 925, chapter 9.
4. An inventory of areas with fixed contamination must be maintained. ESH-1 must be contacted for assistance.
5. Removable contamination shall be reduced to the minimum practicable level before fixative coatings are applied.

Table 14-1 Surface Contamination Values [see 835 Appendix D]

Radionuclide [1]	Removable (dpm/100 cm^2)[2]	Total (Fixed + Removable) (dpm/100 cm^2)[3, 4]
U-natural, U-235, U-238, and associated decay products[5]	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	100[9]
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90.[6, 7]	1,000 beta-gamma	5,000 beta-gamma
Tritium and tritiated compounds[8]	10,000	NA

1. Except as noted in 5 below, the values in this table shall apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. This table shall not apply to personnel contamination. Where contamination by both alpha- and beta-gamma-emitting nuclides is present, the limits established for the alpha- and beta-gamma-emitting nuclides shall apply independently [see 835 Appendix D, note 1].

2. **Guidance Note**: The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an instrument of known efficiency (*Note: The use of dry material may not be appropriate for tritium.*).

   For objects with a surface area of less than 100 cm^2, the entire surface shall be swiped, and the activity per unit area shall be based on the actual surface area. Using swiping techniques to measure removable contamination levels shall not be required if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination [see 835 Appendix D, note 4].

3. **Guidance Note**: The levels may be averaged over 1 square meter provided the maximum activity in any area of 100 cm^2 is less than three times the values in Table 14-1 [see 835 Appendix D, note 3].

4. As used in this table, dpm (disintegrations per minute) shall mean the rate of emission by radioactive material as determined by correcting the counts per minute (cpm) observed by a detector for background, efficiency, and geometric factors associated with the instrumentation.

5. Because of the physical properties of depleted uranium (DU) shrapnel, the contamination values of this appendix shall not apply, and traditional methods/values for specifying levels of contamination are generally inappropriate to the situations in which such shrapnel is created. For DU shrapnel, area designations and contamination control described in Articles 822 and 1424.3, respectively, shall apply.

6. This category of radionuclides shall include mixed fission products, including any Sr-90 that is present. It shall not apply to Sr-90 that has been separated from the other fission products or mixtures in which the Sr-90 has been enriched [see 835 Appendix D, note 5].

7. **Guidance Note**: The average and maximum dose rates associated with surface contamination resulting from beta/gamma emitters should not exceed 0.2 mrad/hr and 1.0 mrad/hr, respectively, at 1 cm.

8. Tritium contamination may diffuse into the volume or matrix of materials; thus, any evaluation of surface contamination shall take into account the extent to which such contamination may migrate to the surface to

ensure the surface radioactivity value provided in this table is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "total" value shall not apply [see 835 Appendix D, note 6].

9. **Guidance Note**: For operational flexibility, a value of 500 dpm/100 cm^2 may be used for releasing items from radiological areas to Radiological Buffer Areas (RBAs) and Radiological Controlled Areas (RCAs). Note 3 also applies to this value as well as to the rest of the values in the "Total" column.

Note: When measuring fixed contamination during a survey, the active area of the probe used must be taken into account. (For example, if the active area is 100 cm^2 and the nuclide is natural uranium, then the 5000-dpm α/100-cm^2 limit shall apply. For a 40-cm^2 probe, 2000 dpm α would be the limit because of the reduced active area of the probe.)

1424 Controlling the Spread of Contamination

1. Work with radioactive or contaminated materials shall be conducted in a manner that minimizes the generation and spread of contamination and shall be consistent with as low as reasonably achievable (ALARA) practices. Administrative and physical controls shall be implemented as required to prevent the spread of removable contamination outside radiological areas, confinement devices, and RBAs under normal operating conditions by personnel, by item and equipment removal, by waste disposal, or by any other means [see 835.1102(a)]. The extent of these controls shall depend on the type and level of contamination present and the activities in and around the area or confinement device.

2. Required controls shall also be maintained and verified to prevent the release of contamination beyond RCAs and areas posted for radiological hazards outside RCAs (for example, Soil Contamination Areas and Radioactive Material Areas [RMAs]) in excess of the levels specified in Table 14-1. Equipment or materials shall be permitted to move directly from or within radiological areas to RBAs and RCAs when surface contamination levels do not exceed those specified in Table 14-1. Items released beyond the RCA and areas posted for radiological hazards outside RCAs (for example, Soil Contamination Area and RMA) must not exceed the levels specified in Table 14-1 and must be decontaminated to ALARA levels.

3. Article 1433.4 in this chapter shall be referred to for information regarding the release of items to uncontrolled areas (for example, sanitary landfill or salvage).

4. Contamination control for depleted uranium (DU) shrapnel shall be required as follows:

   a. Items or materials potentially exposed to DU contamination shall be subject to the Table 14-1 values for U-238 upon any change in custody or use that is expected to end the potential for DU exposure.

   b. Survey and decontamination methods and frequencies shall be conducted as required to prevent the buildup of DU in areas outside RCA boundaries.

   c. Controls shall be established and adjusted based on survey history/results, DU radiation and industrial hygiene hazards, internal/external dose history, incident history, and/or changes to operations that change the characteristics or extent of DU encountered.

   d. Areas posted as RCAs for DU shrapnel only (with no surface or volume contamination) shall be controlled in accordance with facility-specific procedures developed by the facility and reviewed by ESH-1.

5. Items shall not be exposed unnecessarily to contamination; therefore,

   a. work planning and controls shall be established to minimize activation or exposure of items to radioactive contamination;

   b. materials and equipment shall not be carried into any area that has a potential for contamination unless they are required for the activity specific to that area;

   c. an item shall be considered potentially contaminated if it has been used or stored in an area that is controlled for contamination and no one has "acceptable knowledge" of its history; and

d. during the handling, monitoring, or disassembly of items in an area that has the potential for contamination, precautions shall be taken to minimize the spread of contamination and prevent personnel external contamination, exposure, or intake.

6. Contamination must be controlled immediately following its discovery; therefore,

   a. contamination must be controlled immediately through administrative controls;

   b. facility-specific and/or ESH-1 procedures must be adhered to in dealing with any loss of control of radioactive material; and

   c. all items stored in an Airborne Radioactivity Area, Contamination or High Contamination Area, disturbed Soil Contamination Area, or Underground Radioactive Material Area (URMA) shall be treated as contaminated until surveyed and found to be below Table 14-1 levels.

7. Packages containing potentially contaminated items shall be opened in RCAs.

8. The requirements in this chapter shall not be cause for interference with, or delay of, the immediate rescue and medical treatment of persons with potential or actual life- or limb-threatening injuries, persons with injuries of unknown status, or persons in serious distress. Control of the contamination shall be considered, but shall be a secondary priority. Emergency medical responders shall not be impeded during entry or egress to/from any RCAs and associated areas within. Chapter 2 must be referred to for further information regarding the response to personnel injuries in RBAs, RCAs, and radiological areas.

9. Vacuum cleaners and portable air-handling equipment used in Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, RCAs (established for contamination control purposes), or RBAs (established for contamination control purposes) shall be equipped with high-efficiency particulate air (HEPA) filters with the following exceptions:

   a. alternative procedures that are approved by the ESH-1 group leader for a specific operation,

   b. use of a "wet" vacuum cleaner with required controls and ESH-1 team leader approval, and

   c. where tritium is the only radiological hazard.

1425 Monitoring for Personnel Contamination

1. Individuals shall be monitored as required for the presence of surface contamination when exiting Contamination, High Contamination, Airborne Radioactivity Areas, URMAs, and disturbed Soil Contamination Areas [see 835.1102(d)]. Individuals shall perform a whole-body frisk immediately upon entering an uncontaminated area after exiting these areas. Individuals shall also perform a whole-body frisk as directed by the radiation work permit (RWP), hazard control plan (HCP), or ESH-1.

2. In addition to the requirements above, individuals exiting an RBA established for contamination control, RCAs established for contamination control, RMAs, or undisturbed Soil Contamination Areas shall, at a minimum, perform a hand and foot frisk. If other areas of the body or clothing came into contact with potentially contaminated surfaces, those areas of the body or clothing shall also be frisked. The frisk shall be optional if the exit is immediately adjacent to the location where the exiting individual has already performed a whole-body frisk. **Guidance Note**: Some facilities may require a whole-body frisk when one exits these areas (for example, entering uncontrolled areas while wearing anti-C coveralls). Consult facility-specific radiation protection requirements for details.

3. Where frisking cannot be performed at the exit from Contamination, High Contamination, Airborne Radioactivity Areas, URMAs, or disturbed Soil Contamination Areas because of high background radiation levels, individuals shall

   a. remove all protective equipment and clothing at the exit,

   b. proceed directly to the nearest designated monitoring station, and

c. conduct a whole-body frisk.

4. Frisking shall be performed after the individual has removed contaminated protective clothing and before the individual has washed or showered.

5. Personal items, such as notebooks, papers, and flashlights, shall be subject to the same frisking requirements as the individual carrying them. **Guidance Note**: However, acceptable knowledge (see glossary, Attachment U, for definition) may be applied to the release of these items.

6. Instructions for personnel frisking shall be posted adjacent to personnel frisking instruments or monitors.

7. The personnel frisking provisions in this article shall not apply at those facilities that contain only radionuclides, such as tritium, that cannot be detected by currently available hand-held or automated frisking instrumentation. At such facilities, additional emphasis shall be placed on bioassay programs and routine area contamination survey and air sampling programs.

1426 Contamination Controls for Bench Top Work, Laboratory Fume Hoods, Sample Stations, Glove Bags, and Glove Boxes

1. Upon completing work or leaving an area where bench top, fume hood, sample station, glove bag, or glove box work involving unsealed radioactive materials is conducted, individuals who work in these enclosures shall monitor those areas of their bodies that could be potentially contaminated [see 835.1102(d)]. At a minimum, this shall include the hands, arms, feet, and other areas of suspected contamination. **Guidance Note**: A whole-body frisk is recommended at a minimum and may be required in certain facilities.

2. Personal protective equipment (PPE) specific to the facility and operation shall be used. The RWP, HCP, or other work control document shall be consulted for this information.

Part 3 Releasing Items

1431 General Requirements

1. Materials in Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, disturbed Soil Contamination Areas, or URMAs shall be considered contaminated until surveyed by an RCT and released [see 835.1101(a)]. Any equipment or system component removed from a process that may have used or had contact with radioactive material shall be considered contaminated until disassembled to the extent required to perform a survey, surveyed, and shown to be free of contamination at levels exceeding the Table 14-1 values. These survey and release provisions shall not apply to Airborne Radioactivity Areas where only gaseous, short-lived (half-life of 1 hour or less) radionuclides are present. Detailed requirements that shall be implemented for releasing materials from radiological areas are specified in Article 1432 below.

2. The safety- and environment-responsible line-management chain must ensure that administrative and physical controls have been implemented in the workplace to prevent the release of contaminated materials and equipment from areas that are controlled for contamination (for example, Contamination Areas, RBAs, RCAs, and disturbed Soil Contamination Areas). Workers shall be responsible for providing knowledge of process information that will assist in releasing materials and equipment from these areas.

3. The Health Physics Release (HPR) and Health Physics Radioactive Materials Survey (HPRMS) tags shall be used to document the release survey of materials and equipment from areas controlled for contamination. **Guidance Note**: An item removal log may be used in place of the HPR tag. These tags may be obtained from an RCT.

4. Records for releasing materials and equipment shall describe the property, date on which the release survey was performed, identity of the individual who performed the survey, type and identification number of the survey instruments used, and survey results. Creating a separate survey record for each small item and package of similar items (such as boxes of tools or boxes of fasteners) shall not be required. However, the survey record must be detailed enough to identify the individual who is removing the item from the area.

5. **Guidance Note**: Acceptable knowledge may sometimes be used instead of surveys to declare an item free from contamination. Acceptable knowledge may also be applied to personal items, such as notebooks, papers, and flashlights.

1432 Releasing to RBAs and RCAs

Once materials and equipment have been brought into radiological areas controlled for surface contamination or airborne radioactivity, the potential for contamination of the materials and equipment shall be thoroughly evaluated before they are released to RBAs and RCAs. These evaluations shall be conducted to determine the need for measures that would limit the amount of materials and equipment that are brought into radiological areas and the measures that would prevent their contamination if they are brought into these areas.

1. Accessible surfaces of materials and equipment that have been brought into Contamination, High Contamination, Airborne Radioactivity Areas, disturbed Soil Contamination Areas, or URMAs shall be surveyed by an RCT before they are released from these areas to RBAs or RCAs [see 835.1101(a)]. Requirements for conducting these surveys shall be those provided in the footnotes to Table 14-1.
2. If previous use, or acceptable knowledge, determines that inaccessible surfaces are not likely to be contaminated in excess of the limits in Table 14-1, a complete survey of accessible surfaces by an RCT and documentation of the acceptable knowledge shall constitute an approved basis for releasing materials and equipment to the RBA or RCA [see 835.1101(a)(2)].
3. If previous use, or acceptable knowledge, indicates that inaccessible surfaces are likely to be contaminated to levels in excess of the Table 14-1 values for removable contamination, the materials and equipment shall not be released to RBAs or RCAs [see 835.1101(a)(2)], with the following exception. The materials and equipment shall only be released from a radiological area to an RBA or RCA established for contamination control purposes if the following conditions are satisfied:
   a. Removable contamination on accessible surfaces is below the levels specified in Table 14-1.
   b. Materials and equipment shall be routinely monitored by an RCT. Surveys of the materials and equipment shall include the items, areas around the items, and any items or systems that may be connected to or otherwise come in contact with the possibly contaminated surfaces of the possibly internally contaminated items.
   c. The materials and equipment shall be clearly labeled or tagged to alert people to the contamination status. The label or tag shall indicate any precautions required to protect individuals who may be exposed to the hazard.
   d. If surveys indicate the presence of removable contamination in excess of the Table 14-1 limits, the item or area shall be returned to a radiological area established for contamination control purposes or posted as required. The area shall be decontaminated.
   e. Operations and activities shall be controlled to minimize the possibility of release of radioactive contamination from the potentially contaminated items.
   f. Administrative procedures shall be established and implemented to maintain control of these items.
   g. When operations in RBAs or RCAs that involve a released, potentially internally contaminated item have been completed, the item shall be returned to a radiological area established for contamination control purposes or verified as meeting the requirement for release of material and equipment from a radiological area to an RBA or RCA.
4. Removable contamination levels must be less than Table 14-1 values before materials and equipment can be released for unrestricted use in RBAs or RCAs [see 835.1101(a)(1) & (a)(2)].
5. Materials and equipment with fixed contamination levels that exceed the total contamination values specified in Table 14-1, and that have removable contamination levels less than Table 14-1, chapter 14, values, shall

only be released for restricted use in RBAs and RCAs outside of radiological areas [see 835.1101(c) & (c)(1)]. These items shall be routinely monitored by an RCT and clearly marked or labeled to alert individuals to the contaminated status [see 835.1101(c)(2)]. Required administrative procedures shall be established and exercised to maintain control of these items.

6. Materials and equipment with total or removable contamination levels exceeding Table 14-1 values shall only be moved on the site from one radiological area to another if they are monitored as required and the controls and monitoring are established and implemented [see 835.1101(b)].

7. The requirements of 10 CFR 835.1101 shall apply only to materials and equipment that are radioactive because radioactive contamination was deposited on their surfaces. Although DOE has not established any specific controls over the release of volume-contaminated and/or bulk-contaminated (homogeneous/-nonhomogeneous) items from radiological areas, RBAs, and RCAs, the release of these materials and equipment shall be subject to other requirements, including the training requirements of 10 CFR 835.901, the 0.1 rem (1 mSv) in a year radiological controlled area dose expectation of 10 CFR 835.602, and the ALARA requirements of 10 CFR 835.101 and 835.1001. Releasing such items shall be addressed on a case-by-case basis in coordination with ESH-1.

8. When radioactive materials and equipment are moved outside radiological areas, controls shall be established to ensure no unmonitored individual is likely to exceed a dose equivalent that would require monitoring in accordance with Articles 521 and 522, chapter 5.

9. Because of the higher potential for contamination in RBAs established for contamination control purposes, items being removed from an RBA established for contamination control purposes shall also be surveyed and released in accordance with the requirements of this chapter. Efforts shall be made to reduce the levels of contamination on and within items released from an RBA to an RCA as far below the required limits in Table 14-1 as is practical.

1433 Releasing to Uncontrolled Areas

1. Radiological workers shall contact an RCT to survey materials and equipment before releasing them to uncontrolled areas. The person removing the materials and equipment shall be responsible for ensuring the contamination levels of the item meet the release criteria through review of the survey results and acceptable knowledge.

2. ESH-1 shall provide monitoring data and assistance in completing the required documentation.

3. ESH-1 shall maintain the item release survey records.

4. Any item with residual surface radioactivity detected as a result of using readily available survey instruments and normal survey techniques must not be knowingly released to uncontrolled areas. Guidance Note: However, items with residual radioactivity up to and including the levels specified in Table 14-1 may be released to uncontrolled areas on a case-by-case basis in consultation with the area or facility ESH-1 team leader. In this case, every effort should be made to reduce the residual radioactivity as far below the levels in Table 14-1 as practicable in keeping with the ALARA (as low as reasonably achievable) principle before the item is released.

   If the item is suspected to be internally contaminated with radioactive material, it must not be released. The area or facility radiological control technician or ESH-1 team leader must be contacted for further guidance.

   Any item that is volumetrically radioactively contaminated either because of activation by a beam (for example, accelerator operations) or because of the mixing of radioactive material into the item must not be released to uncontrolled areas without approval from ESH-1 and DOE. Guidance Note: DOE has not set specific release limits for volumetric contamination.

5. Consumer products such as smoke detectors, tritium exit signs, thorium-coated camera lenses, and hazardous materials shall be surveyed and shall meet the release criteria in Table 14-1, chapter 14, for any radioactivity beyond that which is intended to be part of the item. Smoke detectors, tritium exit signs, and hazardous materials shall not be disposed of in the sanitary landfill waste stream. The waste management coordinator shall be contacted for instructions on how to dispose of these items.

6. Materials and equipment not immediately released after survey and approval for release shall be controlled to prevent contamination while awaiting release.

7. Facility-specific procedures shall be used to remove waste from a radiological controlled area. These procedures must

   a. describe the applicable waste stream(s);

   b. describe the methods used for waste segregation and management;

   c. describe or identify the quality assurance (QA) program used to verify the effectiveness and accuracy of the waste segregation process and provide specific references to the applicable QA plan and all implementing quality procedures; and

   d. where radiation measurements are used, survey procedures must be described and required documentation, including the QA program, completed to verify the condition of the instruments.

8. Any equipment installed to support processes characterized as potentially radioactive or contaminated must be cleared and tagged by ESH-1 before it can be removed from the RCA.

9. The requirements in this article shall also apply to releases to uncontrolled areas from RMAs, Soil Contamination Areas, and URMAs not located within an RCA.

1434 Recycling of Material with Residual Radioactivity

1. Any item with residual surface radioactivity detected by normal survey instruments and techniques must not be knowingly recycled for use outside Radiological Controlled Areas (RCAs). **Guidance Note**: Items (except for metal or metal-containing items—see below) with residual radioactivity up to and including the levels found in Table 14-1 may be recycled for use outside RCAs on a case-by-case basis in consultation with the area or facility ESH-1 team leader. In this case, every effort should be made to reduce the residual radioactivity level as far below the levels found in Table 14-1 as practicable in keeping with the ALARA (as low as reasonably achievable) principle before the item is recycled for use outside RCAs. If there is any suspicion that the item may be internally contaminated with radioactive material, it must not be recycled for use outside RCAs. Items with residual radioactivity up to and including the levels found in Table 14-1 may be recycled for use within RCAs.

2. However, controls must be imposed on the item or product of recycling (for example, appropriate labeling) to ensure it does not leave the RCA. **Guidance Note**: Contact the area or facility radiological control technician or ESH-1 team leader for further guidance.

3. Any item that is volumetrically radioactively contaminated because of either activation by a beam (for example, accelerator operations) or the mixing of radioactive material into the item must not be recycled for use outside RCAs. DOE has not set specific release limits for volumetric contamination. **Guidance Note**: Items that are volumetrically contaminated may be recycled for use within RCAs if appropriate controls are imposed on the item to ensure that the item is not released beyond the RCA, that the contamination cannot be inadvertently dispersed, and that the dose expectation of an RCA (100 mrem/year) is not exceeded.

4. **Guidance Note**: Any metal item or item containing metal that has originated from an area posted for radiological hazards has additional constraints placed on its release if the intent is to recycle the metal as scrap metal (that is, to be smelted). Consult "Operations Support Tool," titled "Recycling of Metals and Metal-Containing Items from Areas Posted for Radiological Hazards," and E-ESO for further guidance.

Appendix 14A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Contamination Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information.*

   - Controls are implemented for contaminated items and surfaces commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable surface contamination levels. (Article 1421)
   - Fixed contamination areas are (1) periodically surveyed to ensure that the contamination remains fixed, (2) marked to indicate the status of the area, and (3) inventoried. (Article 1423)
   - Administrative and physical controls are implemented as necessary to prevent removable contamination from spreading outside radiological areas, confinement devices, and RBAs under normal operating conditions. (Article 1424.1)
   - Individuals perform a whole-body frisk upon exiting a Contamination Area, High Contamination Area, Airborne Radioactivity Area, URMA, disturbed Soil Contamination Area, or as otherwise directed by an RWP, HCP, or ESH-1. (Article 1425.1)
   - Individuals exiting an RBA or RCA established for contamination control, RMAs, or undisturbed Soil Contamination Areas also perform a hand and foot frisk, at a minimum. Other suspect areas of the body or clothing are also frisked. (Article 1425.2)
   - Upon completing work or leaving the area where bench top, fume hood, sample station, glove bag, or glove box work involving unsealed radioactive materials is conducted, individuals who worked in these enclosures monitor those areas of their body that could be contaminated (at a minimum, the hands, feet, and any areas of suspected contamination). (Article 1426)
   - Materials in Contamination, High Contamination, Airborne Radioactivity Areas, disturbed Soil Contamination Areas, or URMAs are considered contaminated until surveyed by an RCT and released. These materials must not have contamination levels that exceed those of Table 14-1. (Article 1431.1)
   - Materials and equipment are not released to RBAs or RCAs if previous use or acceptable knowledge indicates that inaccessible surfaces of the materials or equipment are likely to be contaminated in excess of the Table 14-1 values for removable contamination (except as noted in Article 1432.3). (Article 1432.3)
   - Radiological workers contact an RCT to survey materials and equipment before releasing them to uncontrolled areas. (Article 1433.1)
   - Materials and equipment are verified to have contamination levels below those specified in Table 14-1 and ALARA before they are released to areas outside of RCAs. (Article 1433.4)
   - Facility-specific procedures meeting the requirements of Article 1433.7 are used to remove waste from RCAs. (Article 1433.7)

External Exposure Control

Contents

External Exposure Control

Appendix 15A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1511 General Requirements

Who	Shall
Safety- and environment-responsible line-management chain	• Verify that administrative and physical controls are available to maintain external exposures in radiological areas and radiological controlled areas below regulatory dose limits and *as low as reasonably achievable* (ALARA). • Directly implement external exposure controls.
Radiological workers	• Review the radiological conditions and associated hazards in the work area, according to the work control processes in place. • Review and implement the external exposure control program for the area. • Notify immediate supervisor of any changes in process or facility configuration that might affect the external exposure control program or dose rates in the work area. • Contact a radiological control technician (RCT) before entering high radiation and very high radiation areas. • Receive training and qualification as a radiological worker (RW).
Health Physics Operations (ESH-1) or other trained and qualified personnel	• Provide radiological monitoring of areas. • Provide assistance in implementing external exposure controls.
Health Physics Measurements (ESH-4)	Maintain and calibrate radiological dose rate survey instruments.

Part 2 Requirements for Controlling External Exposure

The requirements specified in this chapter shall be implemented for the Laboratory's external exposure control program. The program shall consist of both administrative and physical controls such as radiological postings and boundaries, ALARA reviews, use of supplemental dosimetry, hold points, access controls, both permanent and temporary shielding, source reduction techniques, and increasing the distance from a source of radiation. Physical controls (for example, shielding and source reduction techniques) shall be the primary means of maintaining external exposures below regulatory dose limits and ALARA. Administrative controls shall be used only as supplemental methods [see 835.1001(a)]. Chapters 3, 5, 7, 9, and 11 must be referred to for further information on ALARA reviews, supplemental dosimetry, postings, access controls, and work planning, respectively. This chapter elaborates on requirements that shall be implemented for shielding, source reduction techniques, increasing distance between the source of radiation and the worker, and hold points.

1521 Shielding

1. Shielding must be used to reduce external exposures where required and where practicable. (**Guidance Note**: An evaluation should be performed to ensure that more dose is not received as a result of installing and removing the shielding than would be saved from having the shielding present during the operation.) **Guidance Note**: Shielding may be either permanent or temporary. Temporary shielding should be constructed

for (1) one run cycle (such as at an accelerator facility), (2) the duration of a single experiment, (3) a job that lasts less than one year, or (4) shielding that is reconfigured to accommodate a new experiment or modify an existing experiment.

2. Temporary shielding must not be moved or altered in any way without concurrence of both ESH-1 and the safety- and environment-responsible line-management chain. Temporary shielding shall be resurveyed whenever it is altered or moved.

3. Some shielding materials are toxic, such as lead and cadmium; therefore, workers who handle shield materials shall follow industrial hygiene safety practices (contact Industrial Hygiene and Safety [ESH-5] for toxic material concerns).

4. **Guidance Note**: Shielding materials that do not generate mixed waste should be chosen if possible.

5. Radiation surveys shall be performed periodically on temporary shielding to verify its integrity. **Guidance Note**: The frequency of radiation surveys should depend on the specific use of the temporary shielding.

6. A review (contact Nuclear Criticality Safety [ESH-6] for requirements) shall be performed and documented before shielding is used for fissile or fissionable material.

7. **Guidance Note**: The amount and type of temporary shielding should be calculated to achieve the dose rate reduction desired. All temporary shielding calculations should be performed by ESH-1 or Radiation Protection Services (ESH-12) personnel and independently reviewed by ESH-1 or ESH-12 personnel.

8. The ESH-12 Radiological Engineering Team must be involved in the design of permanent or structural shielding.

9. **Guidance Note**: A radiation survey should be performed to verify and document the effectiveness of all shielding, whether permanent, temporary, or altered or modified. The documented survey, not the shielding calculation, should be the acceptance criterion.

10. "Mockups" for planning the shielding design and installation must be considered when practicable. **Guidance Note**: The safety- and environment-responsible line-management chain should evaluate the safety of the installation, including weight loading, seismic qualification, operational safety, and industrial hygiene.

11. **Guidance Note**: Shielding should be installed as close to the source as practicable to minimize the size of the shielding and assembly time.

12. Temporary shielding shall be labeled with the following (or equivalent) wording: TEMPORARY SHIELDING—DO NOT REMOVE WITHOUT PERMISSION FROM ESH-1.

13. The minimum frequency for surveying temporary shielding shall be the same frequency as the room or area in which the shielding is located. **Guidance Note**: This frequency may be specified in facility-specific routine monitoring instructions (RMIs). The physical integrity of the shielding should be inspected at the same time.

14. ESH-1 supervision and the safety- and environment-responsible line-management chain shall be notified when temporary shielding is no longer needed or is not effective.

1522 Source Reduction

Reducing the amount of radioactive material present in a process or system (source reduction) shall be considered as a means of reducing external exposure to personnel. **Guidance Note**: Planning for an operation or experiment involving radioactive material should include the consideration of reducing the amount of radioactive material to the minimum required to effectively carry out the operation or experiment.

1. When consistent with facility and operational requirements, the amount or concentration of radioactive material shall be removed or reduced from the process or system to be worked on. This shall be accomplished by transferring the material to a location that is either shielded or at a far enough distance away from the work

area to effectively reduce the dose rate to an acceptable level. When physically possible, the radioactive material shall be transferred away from the work area by remote control.

2. The safety- and environment-responsible line-management chain shall ensure that the area to which the radioactive material will be transferred will not be adversely affected by the increase in the dose rate in that area.

1523 Increasing Distance from the Source

Whenever practicable, the distance between the worker and the source of radiation must be maximized, either by using remote handling devices or robotics, or by locating staging areas for work activities as far from the source of radiation as possible.

1524 Hold Points

1. Hold points for external exposure control shall include administrative individual dose limits or collective dose limits as specified on a radiation work permit (RWP), hazard control plan (HCP), or other work control document. When these types of hold points are established, workers shall be briefed on them during the pre-job briefing.
2. Workers shall use self-reading dosimeters or electronic dosimeters (or, in some cases, stay-time calculations—see below) to ascertain their approach to the individual dose limit hold point. When the worker reaches the hold point, he or she shall safely configure the work and immediately exit the area to a location of lower dose rate. Article 521.2, chapter 5, must be referred to for further information regarding the use of self-reading and electronic dosimeters.
3. Electronic dosimeters shall be set to alarm at or before the individual dose limit hold point.
4. **Guidance Note**: In some cases (for example, beta or neutron dose fields), it may not be possible to use self-reading or electronic dosimeters capable of responding to the radiation field.

   In the above case, stay-time calculations shall be used to keep workers below individual dose limit or collective-dose-limit hold points.

Appendix 15A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
External Exposure Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter been communicated to the individuals responsible for performing the work.
2. The recommended major implementation criteria for self-assessment of this chapter are the following.
   Note: The article number is given with each bullet to help the reader find more information.

- Shielding is used to reduce external exposures where feasible. (Article 1521.1)
- Temporary shielding may not be moved or altered without the concurrence of ESH-1 and the safety- and environment-responsible line-management chain. (Article 1521.2)
- Radiation surveys are periodically performed on temporary shielding to verify its integrity. (Article 1521.5)
- The ESH-12 Radiological Engineering Team will be involved in the design of permanent or structural shielding. (Article 1521.8)
- Consistent with facility and operational requirements, the amount or concentration of radioactive material will be reduced in or removed from the process or system to be worked on. (Article 1522.1)
- The distance between the worker and the source is maximized whenever possible. (Article 1523)
- When collective or individual-dose-limit hold points are specified, workers use either self-reading dosimeters or electronic dosimeters to determine their approach to the limit. (Article 1524.2)
- When a hold point is reached, workers should safely configure their work and promptly exit the area. (Article 1524.2)
- Stay-time calculations are used to keep workers below their administrative individual dose limit or collective-dose-limit hold points in those radiation fields that cannot be measured with self-reading or electronic dosimeters. (Article 1524.4)

Radioactive Sealed Source Accountability and Control

Contents

Radioactive Sealed Source Accountability and Control

Appendix 16B of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

Radioactive sealed sources (RSS) shall be used, handled, stored, and disposed of in accordance with requirements that are commensurate with the hazards associated with operations involving such sources. This chapter defines the requirements that shall be implemented for enhancing the safe use, handling, storage, transport, and disposal of accountable RSSs to prevent unauthorized use, inadvertent personnel doses, and loss.

1611 Approach to RSS Accountability and Control

For purposes of required radiological surveillance, gas chromatographs (GCs) containing RAM, regardless of the radionuclide activity contained therein, and machine neutron generators, for example, D-D or D-T generators, each as a separate apparatus, are considered accountable RSSs and shall be leak-tested/inventoried in accordance with the requirements specified in this chapter. Embedded RSSs contained in radiation measurement instruments (for example, liquid scintillation counters, area radiation monitors, tritium monitors, process equipment, and so on) shall be logged on to the LRACs for accountability purposes only, as a means of tracking the number and location of embedded RSSs owned by the group. No periodic inventory or leak-testing of embedded RSSs, as defined in the glossary, Attachment U, shall be required.

Guidance Note: LRACs is an Oracle-based database that has been designed to maintain RSS accountability/control records at a central location.

The following process shall be implemented to train personnel on using LRACs and to provide a means to initially input accountable RSSs/GCs containing RAM/machine neutron generators into the LRACs database.

LRACs Training for SCs

Step	Action
1	Personnel in the source control office (SCO) shall be initially trained on the use and limitations of LRACs.
2	SCO personnel shall schedule and train each of the SCs at the Laboratory individually on the use and limitations of LRACs and, thereafter, to any newly designated SC who requests LRACs familiarization training from the SCO.
3	SCO personnel, in close coordination with the responsible SC, shall enter all accountable RSSs/GCs containing embedded RSSs owned by the group into LRACs.
4	Initial data entry into LRACs by SCO personnel and/or the group SC shall be verified by another qualified individual participating in the data entry (that is, SC or SCO individual, etc.) to ensure accuracy before committing the record to the centralized database.

Part 2 User Organization Requirements

1621 Requirements for Group Leaders Owning RSSs, Gas Chromatographs (GCs) Containing RAM, Machine Neutron Generators, and Embedded RSSs

Group leaders who own RSSs, GCs containing radioactive material (RAM), machine neutron generators, and embedded RSSs shall do the following:

1. Ensure that the requirements specified in this chapter are met, including the use of the Laboratory Radioactive Sealed Source Accountability and Control System (LRACS) database to account for and control the RSSs defined in this chapter.
2. Designate and authorize users of (1) RSSs, (2) GCs containing RAM, and (3) machine neutron generators, and *at least one* source custodian within the group.

   Guidance Note: Depending on the total number of RSSs owned by the group, an alternate source custodian as well as a primary source custodian should be designated.
3. Approve long-term RSS storage areas with the concurrence of supporting radiological control technicians (RCTs).
4. Approve or designate active RSS storage areas with the concurrence of supporting RCTs.
5. Approve or designate areas containing RSSs in areas considered unsafe for human entry or so inaccessible that physically accessing the RSS is considered hazardous to the worker [see 835.1202 (d)].
6. Ensure that all new, upgraded, or modified RSS storage areas and machine-neutron-generator-use areas have a radiation shielding design or evaluation documented in writing before the RSS storage area is constructed or modified.
7. Ensure that source custodians and users of RSSs, GCs containing RAM, and machine neutron generators are current on both Radiological Worker Training and Sealed Sources Self-Study Training course 15907 [see 835.103 and 835.901].
8. Ensure that the group source custodian logs all group-owned GCs containing RAM, machine neutron generators, and embedded RSSs onto LRACS.

   Guidance Note: Prevailing federal law (10 CFR.835.104) states that written procedures shall be developed and implemented commensurate with the radiological hazards created by the RSS/GC containing RAM/machine neutron generator-using activities and consistent with the education, training, and skills of the workers exposed to those hazards. For low-activity RSSs, this chapter is construed to fully meet this "written procedure" requirement.

   Guidance Note: ANSI N43.3 (reference 1, section 8.3) recommends that an HCP be compiled for facilities that contain high-activity RSS devices. The SCO will notify groups owning high-activity RSSs of this ANSI N43.3 recommendation.

   If group management decides that the compilation of an HCP is satisfactory for such high-activity RSS devices, then an HCP shall be written in accordance with LIR300-00-02, "Documentation of Safe Work Practices."

1622 Requirements for Source Custodians

Source custodians shall do the following:

1. Provide guidance on implementing the requirements specified in this chapter to facility managers and group leaders, including the names of workers who will require Radiological Worker Training and Sealed Sources Self-Study Training as a result of their need to handle or use RSSs, GCs containing RAM, and machine neutron generators.
2. Ensure that all accountable RSSs, GCs containing RAM, and machine neutron generators located in both active and long-term RSS storage areas and in accessible areas deemed safe for human entry, are physically inventoried at intervals that do not exceed six months in accordance with Article 1651 [see 835.1202(a)]. The responsibility to perform a physical inventory of all accountable RSSs, GCs containing RAM, and machine neutron generators that are located in areas *not* deemed unsafe or inaccessible shall be an SC responsibility that shall not be delegated to any other individual.
3. Ensure that all accountable RSSs, GCs, and machine neutron generators containing RAM which are *not* stored in long-term RSS storage areas or stored in areas deemed inaccessible or unsafe, are leak-tested at intervals that do not exceed 6 months in accordance with Article 1652 [see 835.1202(b) and 835.1202(d)].

   Guidance Note: Leak tests of RSSs containing RAM solely in gaseous form and RSSs whose sole radioactive constituent is gaseous tritium *may* be performed for reasons of contamination control, but are *not* required for RSS accountability or control reasons.
4. Ensure that inventory and leak-test records are maintained on LRACs to demonstrate implementation of the requirements specified in 835.704(f), 835.1201, and 835.1202 of 10 CFR 835.
5. Ensure that the LRACS database is updated with regard to RSS location, authorized RSS user, leak tests, inventories, transfers, disposal, long-term storage status, and inaccessibility of accountable RSSs [see 835.704(f)].
6. Notify the SCO as soon as a new accountable RSS is received so that the manufacturer's American National Standards Institute (ANSI) RSS certification sheet can be scanned into LRACS, if not already done so.

   Guidance Note: This sheet will normally be obtained and scanned into LRACS by the SCO if the RSS comes through the BUS-4 (Materials Management) Shipping and Receiving warehouse.
7. Ensure that RSS storage areas are surveyed by Laboratory RCTs supporting the group, and that such areas are approved by the owning group leader.

1623 Requirements for Users of RSSs, GCs, and Machine Neutron Generators

Users of RSSs, GCs, and machine neutron generators shall complete Radiological Worker Training and Sealed Sources Self-Study Training, course 15907, before using RSSs [see 835.103 and 835.901].

Part 3 Support Organization Requirements

1631 Requirements for Facility Managers

Facility managers shall do the following:

1. Approve, in consultation with the Health Physics Operations (ESH-1) team supporting the FMU, the use of subcontractor-owned RSSs and machine neutron generators within the FMU safety envelope delineated by the facility safety plan (see LPR240-01-00, "Facility and Operating Limits Configuration); and
2. Ensure that all RSS-using operations, GC containing RAM operations, and machine neutron generator operations are fully described within any formal FMU facility safety analysis/authorization basis documentation.

1632 Requirements for the Business Operations Division, Materials Management Group (BUS-4)

The BUS-4 Materials Management Group shall do the following:

1. Notify the Source Control Office (SCO) of all shipments received that are labeled as RAM and suspected to be RSSs, GCs containing RAM, machine neutron generators, or radiation measuring equipment containing embedded RSSs as defined in the Glossary, Attachment U.
2. Provide Department of Transportation-certified RAM shipping services for Los Alamos customers who need to ship RAM by public transportation. LIR405-10-01, "Packaging and Transportation," shall be referred to for packaging and transporting RSSs, GCs containing RAM, machine neutron generators, and equipment containing embedded RSSs. Permanent transfers of RSSs from one SC to another shall be recorded on LRACs.

1633 Requirements for the Business Operations Division, Procurement Group (BUS-5)

The BUS-5 Procurement Group shall do the following:

1. Ensure that commercially available RSSs, GCs containing RAM, and machine neutron generators are purchased from approved vendors.
2. Ensure that wording summarizing the requirements of steps 1–4 of the table below is placed into all subcontracts that could possibly involve the use of *subcontractor-owned* RSSs and/or machine neutron generators on Laboratory property.

Guidance Note: Subcontractor-owned and subcontractor-licensed GCs containing RAM and equipment containing embedded RSSs are not expected to be used on Laboratory property.

The following process shall be implemented for accountable RSSs and/or machine neutron generators that are not Laboratory-owned, as defined in the Glossary, Attachment U.

Subcontractor-Owned and Subcontractor-Licensed RSSs and Machine Neutron Generators Used on Laboratory Property

Step	Action
1	Ensure that all subcontracts involving the use of subcontractor-owned RSSs on Laboratory property specify that the subcontractor is responsible for notifying the SCO (665-5298) as soon as the subcontractor determines *when* its RSSs and/or its machine neutron generators will be used on Laboratory property during the contract period.
2	The subcontractor must provide a copy of a current, valid license to the SCO that proves the subcontractor's authorization to possess and safely use the RSSs and/or machine neutron generator.
3	The subcontractor must coordinate with the SCO to schedule a time when the SCO may review actual, on-site contractor RSSs and/or machine neutron generator operations.
4	If the RSS or machine neutron generator does not meet all stated requirements, the subcontractor shall not be allowed to use the RSS or machine neutron generator on Laboratory property.

1634 Requirements for the ESH-12 Source Control Office (SCO)

The ESH-12 SCO shall do the following:

1. Perform radiation shielding design/evaluations of new or upgraded/modified RSS storage and use locations, depending on requests and funding from the FMU or group leader holding jurisdiction over the RSS storage or use area.

2. When notified by BUS-4 that a RAM shipment has been received at the Laboratory shipping and receiving warehouse, determine if the RAM shipment contains any *new* accountable RSSs and log all *new* accountable RSSs, GCs containing RAM, machine neutron generators, or embedded RSSs into the LRACS database.
3. Assist (when requested) operating groups or external organizations with the Laboratory program governing the accountability and control of RSSs, GCs containing RAM, machine neutron generators, and embedded RSSs, as defined in the Glossary, Attachment U.
4. Inform source custodians or operating groups when they have a high-activity RSS device or facility that falls under ANSI N43.3 and that requires a device- or facility-specific hazard control plan (HCP). See Article 1672 below.
5. Perform initial and periodic radiation surveys, in coordination or conjunction with RCTs, of all Laboratory-owned high-activity RSS devices or facilities that fall under the purview of ANSI N43.3 (reference 1, Part 9).
6. Provide initial LRACS training to all source custodians and, thereafter, to any newly-designated source custodian who requests such training.
7. Upon notification from subcontractors that subcontractor-owned RSSs and/or machine neutron generators will be used on DOE property operated by Los Alamos National Laboratory, verify that the subcontractor personnel are trained by determining if the subcontractor is formally licensed to possess and use the RSSs and/or machine neutron generators involved.
8. Upon notification by a source custodian that a new, accountable RSS has been received, scan the manufacturer's ANSI N43.6 RSS certificate into LRACS.

1635 Requirements for the Health Physics Operations Group (ESH-1)

ESH-1 shall do the following:

1. In coordination with facility managers, group leaders, and source custodians, provide and maintain required radiological posting and labeling for RSSs, RSS storage areas, GCs containing RAM, and machine neutron generators in accordance with chapter 7, Area Designations and Posting, and chapter 17, Labeling, Storing, and Receiving Radioactive Material.
2. Perform leak tests of RSSs, GCs containing RAM, and machine neutron generators in accordance with Article 1652 below when requested by the RSS-owning operating group or responsible source custodian.
3. Perform and document initial radiological surveys of all RSS storage areas to establish the adequacy of such storage areas, containers, and devices, and, thereafter, when requested by the RSS-owning operating group or responsible source custodian.
4. Assist (when requested by facility managers or group leaders) in engineering controls, hazard control plans (HCPs), and other access controls associated with RSS-using activities, GCs containing RAM, and machine neutron generators.
5. Assist and make recommendations to facility managers, group leaders, and source custodians in approving RSS storage locations, including those areas where RSSs may be located in areas considered unsafe for human entry.
6. Perform and document radiological surveys of incoming/outgoing shipments of RSSs, GCs containing RAM, and machine neutron generators when requested by the operating group or responsible source custodian who owns such items and equipment.

1636 Requirements for the Health Physics Measurements Group (ESH-4)

ESH-4 shall do the following:

1. When requested, provide certified radioactivity evaluation results from media (for example, smears and cotton swabs) used to perform leak tests of RSSs, GCs containing RAM, and machine neutron generators.

Radiation-counting equipment used to evaluate media must be capable of detecting the presence of RAM leakage of 0.005 microcuries or less [see 835.1202(b)].

2. Provide external personnel dosimetry service accredited by DOELAP (DOE Laboratory Accreditation Program) to source custodians and users of RSSs, GCs containing RAM, and machine neutron generators who require such dosimetry in accordance with chapter 5 of this document.

3. Provide National Institute of Standards and Technology (NIST) traceable or equivalent calibration services for radiation detection and measurement instrumentation used for health and safety purposes at the Laboratory.

1637 Requirements for the ES&H Training Group (ESH-13)

ESH-13 shall provide Radiological Worker Training and Sealed Sources Self-Study Training, course 15907, and document completion of these courses through the Employee Development System (EDS) for source custodians and users of RSSs, GCs containing RAM, and machine neutron generators.

1638 Requirements for the ESH-12 Radiation Information Management Team

The ESH-12 Radiation Information Management Team shall maintain quality assurance documentation (for example, software life cycle, software verification and validation, software configuration control, LRACS software, and LRACS server hardware) associated with LRACS.

Part 4 General Requirements

1641 Labeling and Posting

1. All RSSs, GCs containing RAM, and machine neutron generators and/or their associated containers shall be labeled "Caution—Radioactive Material" in accordance with chapter 17 of this LIR. Article 1722.3 shall be referred to for label color specifications. Individual RSSs shall be exempted from this labeling requirement if they meet the requirements of Article 1722.8 or they are physically inaccessible.

2. Areas accessible to individuals where accountable RSSs/GCs containing RAM/machine neutron generators are stored or located shall be posted as RMAs. These areas shall be exempted from this posting requirement if

   a. the area is posted as a radiological area; or

   b. each accountable RSS or its associated container is labeled in accordance with the labeling requirements found in Article 1641.1, above; or

   c. the accountable RSS(s) will be in the area for a period of less than 8 continuous hours that is under continuous observation and control of an individual knowledgeable of and empowered to implement required access and exposure control measures. These individuals must be stationed where they can provide direct, line-of-sight surveillance and can give verbal warnings.

1642 Accountability and Control

1. Each group leader who owns RSSs, GCs containing RAM, and/or machine neutron generators shall designate at least one source custodian whose responsibilities for RSSs, GCs containing RAM, and machine neutron generators are set forth in this chapter. LRACS shall be used to demonstrate accountability and control of accountable RSSs.

2. Once an accountable RSS decays below its isotopic accountable threshold activity (listed in Appendix 16A of this chapter), it shall become an "unaccountable" RSS. An operating group shall implement its own program to demonstrate control of unaccountable RSSs. GCs and machine neutron generators containing RAM shall remain "accountable RSSs" for the lifetime of the GC or machine neutron generator regardless of the actual activity level of the radionuclide contained in the GC or machine neutron generator. Embedded RSSs shall be

logged onto the LRACS for purposes of accountability only; no periodic inventory or leak testing of embedded RSSs is required. Article 1647 shall be referred to for further unaccountable source requirements.

1643 Receiving RSSs and RAM-Containing Equipment

BUS-4 shall notify the SCO of all shipments received that are labeled as RAM and suspected to be RSSs, GCs containing RAM, machine neutron generators, or embedded RSSs as defined in the Glossary. The following process must then be implemented.

Step	Action

1	The SCO shall confirm if any of the contents of the shipment received by BUS-4 meet the definition of an RSS, GC containing RAM, machine neutron generator, or embedded RSS according to this LIR.
	• If the shipment does contain one or more of the four items listed above, the SCO shall refer to Appendix 16A of this chapter to determine if the requirements of an accountable RSS are met.
	• If the shipment contents are accountable, the SCO shall
	  • copy the RSS manufacturer's ANSI certification sheet (if it is readily obtainable), and
	  • enter all applicable data into LRACS.

2	The SCO shall inform the responsible source custodian that BUS-4 will be delivering a new accountable RSS, a GC-containing RAM, a machine neutron generator, or an embedded RSS.
3	Once the item is received, the operating group source custodian shall • ensure that the accountable RSS, GC containing RAM, or machine neutron generator is leak-tested, and • complete all information required by the LRACS database, including logging on to the LRACS all embedded RSSs owned by the group.

1644 Storing RSSs

1. Operating groups that own RSSs shall store them in such a way that personnel and dosimetry will not be exposed to sources of radiation.
2. Storage rooms, cabinets, or other containers in which RSSs are stored shall be secured and labeled and posted as required; located in areas where the risk of fire damage is low; and stored in areas free from flammable materials.

3. The following process shall be implemented for storing RSSs:

Step	Action
1	The source custodian shall contact supporting RCTs to ensure that RSS storage areas and/or their storage containers are labeled or posted as required.
2	Source custodians shall report the location of all accountable RSS storage areas (that is, active and long-term) to the SCO through LRACS.
3	RCTs, in support of and with the concurrence of the operating group management, shall perform and document an initial radiation survey for each RSS storage location.

1645 GCs Containing RAM, Machine Neutron Generators, and Embedded RSSs

1. For purposes of required radiological surveillance, GCs containing RAM, regardless of the radionuclide activity contained therein, and machine neutron generators (that is, D-D or D-T generators, each as a separate apparatus) shall be considered accountable RSSs and shall be leak tested/inventoried in accordance with this chapter.
2. Embedded RSSs contained in radiation measurement instruments (for example, liquid scintillation counters, area radiation monitors, tritium monitors, and process equipment) shall be logged onto the LRACS for accountability purposes only as a means of tracking the number and location of embedded RSSs owned by the group. **Guidance Note**: No periodic inventory or leak testing of embedded RSSs, as defined in the Glossary, Attachment U, is required.

1646 Transporting and Transferring RAM-Containing Items

LIR405-10-01, "Packaging and Transportation," shall be referred to for packaging and transportation of RSSs, GCs containing RAM, machine neutron generators, and equipment containing embedded RSSs. Permanent transfers of RSSs from one source custodian to another shall be recorded on LRACS.

1647 Unaccountable RSSs

1. Unaccountable RSSs shall be used, handled, and stored commensurate with the radiological hazard created by such activity.
2. While virtually all embedded RSSs (as defined in the Glossary, Attachment U) are unaccountable, embedded RSSs must be logged onto the LRACS so their whereabouts will be known.

1648 RSS Loss

1. The source custodian shall immediately notify the SCO when the source custodian determines that an RSS cannot be located.
2. Actual loss of an accountable RSS shall trigger an occurrence investigation and an occurrence report at a level (for example, off-normal or unusual) determined by the facility manager in consultation with the group leader of the operating group owning the accountable RSS and ESH-7.

   Guidance Note: Because of their size and typically permanently installed nature, it is not expected that GCs containing RAM, machine neutron generators, or the equipment containing embedded RSSs will become misplaced.

Part 5 Inventory and Leak Test Requirements

1651 Inventory of RSSs, GCs Containing RAM, and Machine Neutron Generators

1. The source custodian shall perform a physical inventory of all accountable RSSs, GCs containing RAM, and machine neutron generators that are located in areas *not* deemed unsafe or inaccessible. This responsibility shall not be delegated to any other individual except as noted below in the second Guidance Note.

   Guidance Note: If the source custodian physically accompanies the supporting RCT as the RCT leak-tests the accountable RSSs, GCs containing RAM, and machine neutron generators, then credit can also be taken, under LRACS, for having conducted a physical inventory if the inventory process below is followed.

   Guidance Note: If the group owning an accountable RSS has loaned the RSS semipermanently to another group at a different location, but still wishes to retain ownership of the accountable RSS, the owning group *may* arrange with the facility manager in whose FMU the borrowed RSS resides for the facility manager to do the inventory, certifying the results to the source custodian of the group who owns the RSS.

2. The following process shall be implemented to inventory accountable RSSs, GCs containing RAM, and machine neutron generators:

Step	Action
1	Group leaders and source custodians shall identify under LRACS all accountable RSSs located in areas unsafe for human entry or inaccessible as defined in this LIR.
2	Group leaders shall authorize all RSSs that are inaccessible or are located in an area that is unsafe for human entry [see 835.1202(d)].
3	Source custodians shall conduct *physical* inventories of accessible, accountable RSSs, GCs containing RAM, and machine neutron generators at intervals that do not exceed six months, including inventories of RSSs in long-term storage areas [see 835.1202(a)]. **Guidance Note**: Semiannual RSS inventories may be extended up to 30 days to accommodate scheduling needs [see 835.3(e)].
4	During the inventory, the source custodian shall verify the physical location and adequacy of the RSS storage areas, RSS containers, GCs containing RAM, and machine neutron generator-use areas, including the associated labeling and posting [see 835.1202(a)(1), (2), and (3)]. The source custodian shall correct deficiencies as soon as possible.
5	Once the inventory and its associated requirements are met, the source custodian shall update the LRACS with the date the physical inventory was actually performed [see 835.704(f)]. **Guidance Note**: By updating LRACS, the source custodian is certifying that all inventory requirements stated in Step 4 above have been implemented and that any deficiencies were corrected.

1652 Leak Testing

1. RSSs that are routinely used and accessible shall be stored and secured in active RSS storage areas when not in actual use. All accountable RSSs located in such active RSS storage locations shall be leak-tested at six-month intervals along with any GCs containing RAM and machine neutron generators owned by the group [see 835.1202(b)].

2. An accountable RSS must be leak-tested before it is placed in a segregated, long-term RSS storage area and the LRACS updated on the long-term storage status and location of the RSS. Once the RSS is in the long-term storage area, semiannual leak tests shall not be required until it is removed from the long-term RSS storage area.

Guidance Note: If the group owning an accountable RSS has lent the RSS semipermanently to another group at a different location, but still wishes to retain ownership of the accountable RSS, the owning group *may* arrange with the facility manager in whose FMU the borrowed RSS resides for the facility manager to leak-test the RSS, reporting the results to the source custodian of the group who owns the RSS.

3. The following process shall be used to leak-test accessible, accountable RSSs, GCs containing RAM, and machine neutron generators:

Step	Action
1	Source custodians shall arrange with supporting RCTs to have all accountable RSSs, GCs containing RAM, and machine neutron generators leak-tested upon initial receipt; at intervals that do not exceed 6 months; when packaged for shipment; when damage is suspected; and before or upon returning an accountable RSS in long-term storage to active service [see 835.1202(b)]. **Guidance Note**: Semiannual leak tests may be extended by a period not to exceed 30 days to accommodate scheduling needs [see 835.3(e)].
2	Source custodians shall take accountable RSSs, GCs containing RAM, and machine neutron generators out of service and place the RSSs in a segregated, long-term RSS storage location (separate from leak-tested items) if they are not leak-tested within the time specified in Step 1.
3	Source custodians shall update LRACS regarding (1) RSSs, GCs containing RAM, and machine neutron generators taken out of service, with RSSs placed into segregated long-term RSS storage areas and (2) leak test results as soon as practical after the RCT supporting the group provides the leak test results to the source custodian who requested the leak test.
4	If the leak test results of an accountable RSS, GC containing RAM, or machine neutron generator indicate significant removable activity (as determined by the ESH-1 team leader supporting the group), supporting RCTs shall determine if the RSS/GC/machine neutron generator is merely externally contaminated or actually leaking RAM outward from where the RAM normally resides (see LIG402-700-01).
5	For accountable RSSs, GCs containing RAM, and machine neutron generators that are found to be externally contaminated, supporting RCTs shall provide requirements to accomplish the necessary decontamination.
6	Accountable RSSs, GCs containing RAM, and machine neutron generators that supporting RCTs determine to be leaking shall be controlled as required to minimize the spread of radioactive contamination (that is, taken out of service, segregated, and containerized) [see 835.1202(e)]and then processed for disposal in accordance with LIR404-00-02, "General/Waste Management Requirements," and LIR404-00-05, "Managing Radioactive Waste," (see Article 1662 below).
7	As soon as an RSS is determined to be leaking, the source custodian shall update the LRACS and immediately notify the SCO.

Part 6 Disposing of RSSs

1661 Minimizing the Number of RSSs

The safety measures that must be implemented to protect workers from occupational radiation shall be commensurate to the nature and size of the total Laboratory radiation source term. Accordingly, all operating groups shall keep the total number of accountable RSSs to the operationally required *minimum.*

Guidance Note: While it is permissible to place RSSs no longer routinely used in a long-term RSS storage area designated and approved by the group leader owning the RSS, it is preferable to dispose of RSSs that are no longer needed.

1662 Disposing of RSSs and RAM-Containing Items

1. Before the RSS disposal process is initiated for an RSS, GC containing RAM, machine neutron generator, or embedded RSS that is no longer needed, the source custodian shall first contact the manufacturer to ascertain whether or not the RSS or RAM-containing component can be sent back to the manufacturer for disposal, rather than being disposed of in the Laboratory's radioactive waste stream.
2. Source custodians, who are informed by their group manager when an RSS, GC containing RAM, machine neutron generator or equipment containing an embedded RSS is no longer required, shall dispose of the RSS and RAM-containing component in accordance with LIR404-00-02, "General/Waste Management Requirements," and LIR404-00-05, "Managing Radioactive Waste." **Guidance Note**: In general, the RAM disposal process begins when the source custodian contacts the waste management coordinator supporting the operating group.
3. Source custodians shall not delete an RSS, GC containing RAM, machine neutron generator, or equipment containing an embedded RSS from LRACS until the disposed of RSS or RAM-containing component has been packaged for disposal, transported to TA-54, and delivered into the custody of TA-54 low-level-waste disposal personnel. Before deleting the disposed-of RSS, GC containing RAM, machine neutron generator, or embedded RSS from the LRACS, the source custodian shall update the LRACS record with the date of disposal, disposal identification number, and any other information that LRACS requires about the disposal.
4. Through Public Law 99-240, the DOE shall safely store and dispose of "greater than Class C" actinide-containing RSS waste as defined in 10 CFR 61.55. The institution's organization manager shall be responsible for executing the "DOE Offsite Source Recovery Project," a project intended to develop an approved, safe means of disposal of "greater than Class C" actinide-containing RSS waste. Because actinide-containing RSSs (for example, plutonium–beryllium and americium–beryllium sources) fall into this "greater than Class C" RSS waste category, RSSs such as these, once declared as "waste," shall be disposed of in accordance with the requirements of the project. Groups owning "greater than Class C" actinide-containing RSSs shall contact the Laboratory's "Offsite Source Recovery Project" personnel for disposal instructions.
5. **Guidance Note**: Refer to Article 1726 for requirements regarding the disposal of items containing RAM as excess property (that is, salvage).

Part 7 Documentation

1671 LRACS

1. The unclassified LRACS is the only Laboratory-wide database system that shall be used to account for and control accountable RSSs, GCs containing RAM, machine neutron generators, and embedded RSS owned by Laboratory operating groups.

   Guidance Note: Some RSSs tracked under the nuclear materials accountability program should also be tracked under the LRACS, because such RSSs should be periodically leak-tested for occupational radiation safety purposes.
2. The ESH-12 Radiation Information Management Team shall maintain documentation on the LRACS. See Article 1638 above.

1672 Hazard Control Plan for High-Activity RSS Devices and Facilities

1. A device-specific HCP shall be written in accordance with LIR300-00-02, "Documentation of Safe Work Practices," and for facilities that contain high-activity RSS devices. The SCO shall inform operating groups when they have RSSs in this category.
2. Prevailing federal law (see 10 CFR 835.104) states that written procedures shall be developed and implemented (1) commensurate with the radiological hazards created by the use of RSSs, GCs containing RAM, and machine neutron generators and (2) consistent with the education, training, and skills of the

workers exposed to those hazards. For low-activity RSSs, this chapter shall be considered to fully meet this "written procedure" requirement.

Guidance Note*:* Group leaders are permitted, though not required, to direct the compilation of an accountable-RSS-specific HCP for any non-high-activity RSS owned by the group.

Part 8 Directory of Resources

ESH-12 Source Control Office (SCO).

Part 9 Related Documents

American National Standards Institute (ANSI) N43.3, "American National Standard for General Radiation Safety—Installations Using Non-medical X-Ray and Sealed Gamma-Ray Sources, Energies Up To 10 MeV"

ANSI N43.6, "Sealed Radioactive Sources, Classification"

DOE Order 474.1, Control and Accountability of Nuclear Materials

International Organization for Standardization (ISO) Standard 2919, "Radiation Protection—Sealed Radioactive Sources—General Requirements and Classification

ISO International Standard ISO 9978, Radiation Protection—Sealed Radioactive Sources—Leakage Test Methods

LIR300-00-01, "Safe Work Practices"

LIR300-00-02, "Documentation of Safe Work Practices"

LIR404-00-02, "General/Waste Management Requirements"

LIR404-00-05, "Managing Radioactive Waste"

LIR405-10-01, "Packaging and Transportation"

LIG402-700-01, "Occupational Radiation Protection Guidance"

Public Law 99-240, "Low-Level Radioactive Waste Policy Amendments Act of 1985, 99th Congress, January 15, 1986"

Title 10, Code of Federal Regulations, Part 61, Licensing Requirements for Land Disposal of Radioactive Waste

Title 10, Code of Federal Regulations, Part 835, Subpart A, Subpart F, Subpart H, Subpart M and Appendix E

Appendix 16A
Radioactive Sealed Source (RSS)
Accountability Threshold Activity Levels (*in microcuries*)

Nuclide	Accountability Threshold Activity	Nuclide	Accountability Threshold Activity	Nuclide	Accountability Threshold Activity
^{3}H	160,000,000	^{89}Sr	240,000	^{119m}Sn	330
^{7}Be	3,200	^{90}Sr	7,700	^{121m}Sn	870,000
^{10}Be	28,000	^{90}Sr-Y	100	^{123}Sn	13,000
^{14}C	4,800,000	^{88}Y	34	^{126}Sn	180
^{22}Na	19	^{91}Y	50,000	^{124}Sb	91
^{26}Al	16	^{88}Zr	120	^{125}Sb	68
^{32}Si	9,900	^{93}Zr	31,000	^{121m}Te	190
^{35}S	4,000,000	^{95}Zr	200	^{123m}Te	280
^{36}Cl	460,000	^{91}Nb	70	^{125m}Te	440
^{40}K	280	^{91m}Nb	360	^{127m}Te	800
^{41}Ca	7,400,000	^{92}Nb	18	^{129m}Te	2,300
^{45}Ca	1,500,000	^{93m}Nb	440	^{125}I	350
^{46}Sc	62	^{94}Nb	23	^{129}I	180
^{44}Ti	160	^{95}Nb	340	^{134}Cs	27
^{49}V	29,000,000	^{93}Mo	77	^{135}Cs	2,200,000
^{53}Mn	20,000,000	^{95m}Tc	130	^{137}Cs	60
^{54}Mn	65	^{97}Tc	81	^{133}Ba	52
^{55}Fe	3,700,000	^{97m}Tc	360	^{137}La	110,000
^{59}Fe	200	^{98}Tc	25	^{139}Ce	240
^{60}Fe	13,000	^{99}Tc	6,800,000	^{141}Ce	2,400
^{56}Co	40	^{103}Ru	440	^{144}Ce	1,500
^{57}Co	230	^{106}Ru	21,000	^{143}Pm	130
^{58}Co	140	^{101}Rh	250,000	^{144}Pm	29
^{60}Co	18	^{102}Rh	83,000	^{145}Pm	260
^{59}Ni	7,500,000	^{102m}Rh	210,000	^{146}Pm	45
^{63}Ni	3,200,000	^{107}Pd	780,000	^{147}Pm	250,000
^{65}Zn	110	^{105}Ag	2,100,000	^{148m}Pm	110
^{68}Ge	570	^{108m}Ag	18	^{145}Sm	910,000
^{73}As	540	^{110m}Ag	22	^{146}Sm	120
^{75}Se	64	^{109}Cd	160	^{151}Sm	250,000
^{79}Se	1,000,000	^{113m}Cd	6,500	^{148}Eu	700,000
^{83}Rb	92	^{115m}Cd	10,000	^{149}Eu	5,300,000
^{84}Rb	200	^{114m}In	780	^{150}Eu	100
^{85}Sr	120	^{113}Sn	310	^{152}Eu	31

Appendix 16A–continued
Radioactive Sealed Source (RSS)
Accountability Threshold Activity Levels (*in microcuries*)

Nuclide	Accountability Threshold Activity	Nuclide	Accountability Threshold Activity	Nuclide	Accountability Threshold Activity
^{154}Eu	31	^{194}Os	15,000	^{237}Np	19
^{155}Eu	370	^{192}Ir	140	^{236}Pu	69
^{146}Gd	260,000	^{192m}Ir	26,000	^{237}Pu	330
^{148}Gd	30	^{194m}Ir	27	^{238}Pu	25
^{151}Gd	1,100,000	^{193}Pt	44,000,000	^{239}Pu	23
^{153}Gd	210	^{195}Au	480	^{240}Pu	23
^{157}Tb	2,500	^{194}Hg	35,000	^{241}Pu	1,200
^{158}Tb	39,000	^{203}Hg	490	^{242}Pu	24
^{160}Tb	120	^{204}Tl	22,000	^{244}Pu	25
^{159}Dy	4,100,000	^{202}Pb	100,000	^{241}Am	23
^{166m}Ho	22	^{205}Pb	91	^{242m}Am	24
^{168}Tm	100	^{210}Pb	92	^{243}Am	23
^{170}Tm	8,400	^{207}Bi	17	^{241}Cm	68,000
^{171}Tm	28,000	^{208}Bi	15	^{242}Cm	580
^{169}Yb	550	^{210m}Bi	1,300	^{243}Cm	33
^{173}Lu	440,000	^{208}Po	10	^{244}Cm	40
^{174}Lu	250,000	^{209}Po	6,300	^{245}Cm	22
^{174m}Lu	390,000	^{210}Po	1,100	^{246}Cm	22
^{177m}Lu	58	^{226}Ra	1,200	^{247}Cm	24
^{172}Hf	31,000	^{228}Ra	2,100	^{248}Cm	6.0
^{175}Hf	1,800,000	^{227}Ac	1.5	^{250}Cm	1.1
^{178m}Hf	4,100	^{228}Th	29	^{247}Bk	17
^{181}Hf	350	^{229}Th	4.7	^{249}Bk	7,200
^{182}Hf	3,000	^{230}Th	31	^{248}Cf	200
^{179}Ta	1,500,000	^{232}Th	6.1	^{249}Cf	17
^{182}Ta	73	^{231}Pa	7.8	^{250}Cf	38
^{181}W	1,100	^{232}U	15	^{251}Cf	17
^{185}W	3,900,000	^{233}U	74	^{252}Cf	64
^{188}W	64,000	^{234}U	75	^{254}Cf	34
^{183}Re	540	^{235}U	67	^{252}Es	10
^{184}Re	260	^{236}U	80	^{254}Es	63
^{184m}Re	150	^{238}U	84	^{255}Es	46,000
^{186m}Re	280,000	^{235}Np	120	^{257}Fm	430
^{185}Os	140	^{236}Np	22	^{258}Md	600

Notes: Any alpha-emitting radionuclide not listed above and mixtures of alpha-emitters of unknown composition shall have a value of 10 microcuries. Any radionuclide other than alpha-emitting radionuclides not listed above and mixtures of beta-emitters of unknown composition shall have a value of 100 microcuries. Where a combination of radionuclides in known amounts is involved, derive the value for the combination as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the value otherwise established for the specific radionuclide when not in combination. If the sum of such ratios for all radionuclides in the combination exceeds unity (1), then the accountability criterion shall have been exceeded.

Appendix 16B
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radioactive Sealed Source Accountability/Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - Group leaders know about and approve of the activities involving RSSs, GCs containing RAM, and machine neutron generators in their group, and LRACS is used to account for and control all "accountable" RSSs, GCs containing RAM, and machine neutron generators at Los Alamos National Laboratory. (Article 1621)
   - Source custodians in conjunction with supporting RCTs ensure that (1) RSS storage areas are approved and posted in accordance with prevailing Laboratory directives regarding radiological posting/labeling and (2) accountable RSSs, GCs containing RAM, and machine neutron generators are inventoried and leak-tested at six-month intervals. (Article 1622)
   - BUS-4 understands that the cradle-to-grave accountability and control of RSSs and RAM-containing items and equipment begins when RSSs are first received at the Laboratory shipping and receiving warehouse. (Article 1632)
   - BUS-5 understands the necessity of placing appropriate contractual language into all subcontracts involving the use of subcontractor-owned RSSs and machine neutron generators on Los Alamos National Laboratory property. (Article 1633)
   - Laboratory RCTs provide full radiological support to the operating group's use of RSSs, GCs containing RAM, and machine neutron generators. (Article 1635)
   - ESH-12 maintains all quality assurance documentation associated with LRACS and, when requested by DOE, defends the effectiveness of LRACS in complying with 10 CFR 835. (Article 1638)
   - Group leaders ensure that the GCs containing RAM and machine neutron generators are treated as if they are "accountable" RSSs. (Article 1645)
   - RSSs and RAM-containing items and equipment, upon transfer or disposal, are packaged for shipment in accordance with prevailing Laboratory and DOT directives governing RAM transport. (Article 1646)
   - Accountable RSSs, GCs containing RAM, and machine neutron generators are inventoried and leak-tested at intervals that do not exceed six months, in accordance with Articles 1651 and 1652.

Labeling, Storing, and Receiving Radioactive Material

Contents

Labeling, Storing, and Receiving Radioactive Material

Appendix 17A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1711 General Requirements

Who	Shall
Radiological workers	• Immediately contact ESH-1 (Health Physics Operations) when packages of radioactive material are received from transportation at the facility or activity. • Label and store radioactive materials as required by this chapter.
ESH-1	Provide assistance to the safety- and environment-responsible line-management chain with receiving, labeling, and storing radioactive materials.
BUS-4 Packaging and Transportation Team	As authorized by ESH-1 Radiological Surveillance Authorization Agreements (RSAAs), immediately perform radioactive material receipt surveys as specified in this chapter or immediately contact ESH-1 to perform the surveys.
ESH-1 RCTs	Perform radioactive material receipt surveys and labeling.

Part 2 Labeling, Storing, and Receiving Radioactive Material

1721 General

Radioactive material located within radiological areas shall not require specific labeling or packaging if enough information is provided to allow individuals to take required protective actions [see 835.606(a)]. The information shall be provided by means of postings, pre-job briefings, training, or other stated requirements.

1722 Labeling Radioactive Material

1. Individual containers of radioactive material and/or radioactive items shall be labeled except under certain specified conditions in which existing postings and control measures provide required warning [see 835.605(a) and 835.606(a)].
2. Postings and/or access control requirements for radiological areas generally provide sufficient personnel protection to negate the need for individual container or item labeling; however, items having removable contamination in excess of the Table 14-1, chapter 14, values shall be labeled when used, handled, or stored in areas other than Contamination, High Contamination, or Airborne Radioactivity Areas.
3. Labels shall include the standard radiological warning trefoil and the words CAUTION or DANGER and RADIOACTIVE MATERIAL [see 835.605]. The radiation-warning trefoil shall be black or magenta imposed upon a yellow background [see 835.601(a)]. Black is the preferred color for the trefoil and the lettering. **Guidance Note**: Radioactive materials labels applied to radioactive sealed sources may be excepted from these color specifications [see 835.606(b)].
4. Labels shall also provide the information (such as radionuclide present, estimated quantity of radioactivity, date for which the activity was estimated, and radiation levels) required to allow individuals handling, using, or working in the vicinity of the labeled material to take required actions to control exposures [see 835.605].
5. **Guidance Note**: If an item is too small to be labeled with all the desired information, the label should be applied to the device or storage location with enough information available to trace the item to the appropriate label.

6. If a label is applied to packaged radioactive material, it shall be applied to the outside of the package or be visible through the package.

7. Radioactive materials and containers shall be labeled in accordance with Table 17-1 below.

Table 17-1 Labeling Radioactive Material

Item/Material	Required Labeling[a]	Supplemental Labeling
Equipment, components, and other items that are radioactive, potentially radioactive, or have been exposed to radioactive contamination or activation sources	Standard radiation warning trefoil, and CAUTION or DANGER and RADIOACTIVE MATERIAL [see 10 CFR 835.605]	CONTAMINATED or POTENTIALLY CONTAMINATED
Sealed and unsealed radioactive sources or associated storage containers		Refer to chapter 16.
Equipment, components, and other items with actual or potential internal contamination		INTERNAL CONTAMINATION or POTENTIAL INTERNAL CONTAMINATION
Components, equipment, or other items with fixed contamination		FIXED CONTAMINATION

[a]Labeling required on item or container meets the labeling criteria established in 10 CFR 835.605.

8. Items and containers shall only be excepted from labeling in accordance with Table 17-2 below.

Table 17-2 Exceptions from Requirements for Labeling Radioactive Material

Exception Criteria	Items Typically Included[a]
Material that is used, handled, or stored in Radiological Areas, Radioactive Material Areas (RMAs), Radiological Buffer Areas (RBAs), or Radiological Controlled Areas (RCAs) and enough information is given to permit individuals to take precautions or control exposures [see 835.606(a)(1)]	All radioactive material in radiological areas and radioactive material areas. This exception shall not be applied to items that have removable contamination exceeding the Table 14-1, chapter 14, values that are stored outside Contamination, High Contamination, or Airborne Radioactivity Areas.
Material having a total quantity of radioactive material below one tenth of the Appendix 16A, chapter 16, values [see 835.606(a)(2)] **Guidance Note**: We recommend that radioactive items and containers of radioactive material (measurable over background using ordinary means) be labeled as such even if the quantity of radioactive material is less than one tenth of the values specified in Appendix 16A. Labeling would ensure that information on the material's radioactivity would not be lost.	Items having extremely low levels of radioactive material content, such as low-activity sealed radioactive sources, laundered personal protective equipment, and tools, as well as equipment having low levels of fixed contamination
Material that has been packaged, labeled, and marked in accordance with the applicable (for example, DOE or Department of Transportation) radioactive material transportation requirements [see 835.606(a)(3)]	Radioactive material packages awaiting shipment
Material that is inaccessible, or accessible only to individuals authorized to handle or use it or work in its vicinity [see 835.606(a)(4)]	Material stored in locked areas or areas having strict physical and administrative entry controls that preclude unauthorized entry and radioactive samples being handled or transported by authorized personnel.
Material that is installed in manufacturing, process, or other equipment [see 835.606(a)(5)]	Piping, tanks, valves, instrument sensors, test sources, and so forth, that are installed in immobile systems
Material that consists solely of nuclear weapons or their components [see 835.606(a)(6)]	Nuclear weapons components

[a] The listed items must meet the criteria established in the first column; and other requirements such as dose limits for members of the public (Table 4-1, chapter 4), training requirements (Appendix 8A, chapter 8), ALARA requirements (chapter 3), and RCA dose expectation (Article 722, chapter 7) must be implemented in the absence of radioactive material labels.

1723 Packaging Radioactive Material

Radioactive material that is outside Contamination, High Contamination, or Airborne Radioactivity Areas and is confirmed or suspected to have removable radioactive contamination levels greater than Table 14-1, chapter 14, values shall be securely wrapped in plastic or placed in a closed container to prevent the spread of contamination.

1724 Storing Radioactive Material

1. Radioactive material in quantities exceeding the Appendix 16A, chapter 16, quantities shall be used, handled, and stored in an RMA (see Article 726, chapter 7) or other area posted in accordance with Articles 724 or 725 except as noted in Article 726 [see 835.2(a), radioactive material area, and 835.603].

2. Quantities of radioactive material stored in RMAs located outside Radiological Controlled Areas (RCAs) shall be limited to the amount of material presenting an external radiation hazard such that the dose expectations of an RCA are not exceeded as a result of storing the material in the RMA. In addition, only radioactive material that does not present a contamination hazard by the inherent nature of its form or packaging (for example, encapsulated sources or activated metals) shall be allowed in these areas.

1725 Receiving Radioactive Material from Transportation

1. **Guidance Note**: The Laboratory has an established packaging and transportation program defined in LPR405-00-00.0, "Packaging and Transportation," LIR405-10-01.0, "Packaging and Transportation," and the Packaging and Transportation Quality Assurance Plan.

   The requirements defined in these documents shall be implemented for transporting and receiving radioactive material from both off-site and on-site conveyances.

2. Specific arrangements shall be made for receiving packages containing radioactive material, regardless of the means of conveyance, in excess of Type A quantities (as defined in 10 CFR 71.4). These arrangements shall be made for receiving packages upon delivery or retrieving the package immediately after receiving notification of delivery [see 835.405(a)].

3. When radioactive material that is equal to or exceeding a Type A quantity (as defined in 10 CFR 71) is received, the radiation dose rate of the received package shall be monitored in either of the following cases:

   a. the package is labeled as Radioactive White I or Yellow II or III label [see 835.405(b)(1)], or

   b. the package has been transported as low-specific-activity material on an exclusive-use vehicle [see 835.405(b)(2)].

4. When radioactive material is received (other than gaseous or special-form materials), the package shall be monitored for contamination in either of the following cases:

   a. the package is labeled as Radioactive White I or Yellow II or III label) [see 835.405(b)(1)], or

   b. the package has been transported as low-specific-activity material on an exclusive vehicle [see 835.405(b)(2)].

5. A package containing radioactive material of any type or quantity that arrives damaged (crushed or wet, for example) shall be monitored for external radiation and contamination [see 835.405(b)(3)].

6. Packages of radioactive material shall be monitored as soon as possible after they are received but no later than eight hours following the beginning of the working day after the package is received [see 835.405(d)].

7. The monitoring described above shall be performed when the radioactive material is received at the SM-30 warehouse, and again when it is received at the final destination. The monitoring described above shall also be performed when the radioactive material is shipped from one facility to another facility on the site or is not initially received at the SM-30 warehouse.

8. Contamination surveys shall incorporate requirements and techniques to detect both removable and fixed contamination, except as specified in note 2, paragraph 2, of Table 14-1.

1726 Disposing of Items Containing Radioactive Material As Excess Property

1. Any item that intentionally contains radioactive material must not be offered as excess property unless

   a. the item or quantity of material has been exempted from licensing requirements by the US Nuclear Regulatory Commission (Title 10 of the Code of Federal Regulations) or Agreement State and the item will be used for its intended purpose;

   b. the item is a consumer product and will be used for its intended purpose, for example, smoke detectors, luminous dial items, and liquid scintillation counters containing an "embedded" radioactive source; or

   c. the item is being transferred to an entity licensed by the US Nuclear Regulatory Commission or an Agreement State and it has been ascertained that the transfer of the item does not violate any requirement of the license.

2. **Guidance Note**: In either case, because of the complexity of interpreting whether an item meets these criteria, consult with the ESH-12 Source Control Office at 667-8085 to determine if the item can be offered as excess property. ESH-12 will then make the required notifications to the authorities who need to know about transferring the item containing radioactive material to non-LANL entities.

Appendix 17A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Radioactive Material Storage, Labeling, and Receipt	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - Individual containers of radioactive material and radioactive items are labeled (see Table 17-1) except under certain conditions (see Table 17-2). (Article 1722.1)
   - These labels include the standard radiological warning trefoil and the words CAUTION or DANGER, and RADIOACTIVE MATERIAL, with a black or magenta trefoil and wording on a yellow background. (Article 1722.3)
   - Labels include enough information to allow individuals handling, using, or working in the vicinity of the material to take appropriate precautions. (Article 1722.4)
   - Radioactive material that is outside Contamination, High Contamination, or Airborne Radioactivity Areas and is confirmed or suspected to have removable contamination in excess of Table 14-1 values is securely wrapped in plastic or placed in a closed container to prevent the spread of contamination. (Article 1723)
   - Radioactive material that exceeds a Type A quantity and is labeled as Radioactive White I, Yellow II, or Yellow III, or that has been transported as low-specific activity on an exclusive-use vehicle, is surveyed for dose rates upon receipt in accordance with the time limits specified in Article 1725.6. (Article 1725)
   - Radioactive material (other than gaseous or special-form materials) labeled as Radioactive White I, Yellow II, or Yellow III, or that has been transported as low-specific activity on an exclusive-use vehicle, is surveyed for contamination upon receipt in accordance with the time limits specified in Article 1725.6. (Article 1725)

X-Ray Generating Devices and Facilities Control

Contents

X-Ray Generating Devices and Facilities Control

Appendix 18A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

Guidance Note: Although some portable x-ray-generating devices (XGD) can be used in an open environment, most XGDs are permanently installed within an enclosure or larger shielded exposure room.

The combination of the XGD and its contiguous interlocked and/or shielded enclosure/room shall constitute the x-ray-generating facility (XGF) This chapter describes the requirements that shall be implemented for using and operating XGDs and XGFs safely. Refer to chapter 9, Appendix A, of this LIR for XGD/XGF (a subset of Radiation-Producing Devices and Facilities) access control requirements.

Part 2 User Organization Requirements

This chapter shall apply to all laboratory organizations and any subcontractors that use Laboratory-owned XGDs on-site or off-site or subcontractor-owned XGDs on-site.

1821 Requirements for Group Leaders

Group leaders who own XGDs and XGFs shall do the following:

1. Ensure that the requirements specified in this chapter are implemented. XGFs shall have features that shall be used to ensure the safety of the XGD operators and the public.
2. Ensure that all new XGFs and upgraded or modified XGDs installed in an existing XGF have a radiation shielding design or evaluation documented in writing before the new or upgraded or modified XGD is installed in the XGF [see 835.1001(a)].

   Guidance Note: If the radiation shielding design or evaluation identifies the "safe work practice" need for additional heavy structural radiation shielding in the facility housing the XGF, the facility manager should be drawn into the process at that point.
3. Designate and authorize XGD and XGF custodians and operators.
4. Review and approve, in consultation with supporting RCT personnel, the radiological access controls associated with group XGDs and XGFs in accordance with this chapter and chapter 9 of this LIR.
5. Request the XCO (XGD and XGF control office) to perform a radiation safety survey of any XGD that has undergone refurbishment, modification, or upgrade that may have altered any of the following: (1) the XGD primary radiation beam output; (2) the dimensions (degree of collimation), energy, or primary x-ray beam orientation (direction) compared with the most recent survey; or (3) the engineered safety systems (for example, interlocks, warning lights, exclusion fences, shielding) [see 835.401(a)(5)].

   Guidance Note: The XCO can be contacted through the ESH-12 (Radiation Protection Services) group office.
6. Provide and maintain required radiological posting for group XGD and XGF operations described in the safety analysis/authorization basis document for the facility-management unit in accordance with chapter 7 of this LIR.
7. For group-owned portable XGDs that are used in off-site programs and operations (for example, the Joint Tactical Operations Team and the Accident Response Group), ensure that the hazard control plan (HCP) addresses off-site as well as on-site operations (if used on-site) and that required x-ray safety support personnel and equipment are provided by the program or group when the XGD is deployed off-site.

8. For group-owned XGDs permanently installed at off-site locations (for example, the New Mexico Institute of Mining and Technology and the University of New Mexico), ensure that any HCP-like documentation required by the off-site safety personnel (FM-like) at the location where the XGD is used and operated is formulated and coordinated.

9. Ensure that training is conducted at Los Alamos National Laboratory, on-site, with portable XGDs that are required for use off-site (for example, the Joint Tactical Operations Team and the Accident Response Group operations). Group leaders who own portable intentional XGDs used off-site shall ensure that the XGD operators who are training on-site for eventual off-site XGD use are supported by required x-ray safety personnel and that these supporting x-ray safety personnel are equipped with the required, calibrated, health and safety radiation monitoring instrumentation.

10. Ensure that all Laboratory x-ray operations conducted on-site and off-site have the required level of x-ray safety support. This includes x-ray safety personnel with the required training and work authorization and the required, calibrated x-ray monitoring instrumentation.

    Guidance Note: For x-ray operations conducted off-site, Laboratory x-ray safety personnel should coordinate with the radiological control organization of the host facility.

11. Ensure that training on-site and operations off-site involving portable intentional XGDs are conducted in accordance with an approved HCP. If no HCP exists covering such operations, then the operations, both on-site and off-site, shall be conducted and documented under a radiological work permit (RWP).

12. Ensure that XGD and XGF custodians and operators are provided with the required radiation personnel dosimetry in accordance with chapter 5.

    Guidance Note: XGD and XGF custodians and operators who work only with Class I XGDs do not normally need individual personnel dosimeters.

13. Ensure that XGD and XGF custodians and operators of low-hazard (Class I) XGFs have, at a minimum, x-ray safety training [see 835.103].

    Guidance Note: Class I XGD and XGF custodians and operators may also take radiological worker training.

14. Ensure that XGD and XGF custodians and operators of Class II and Class III XGFs are current on *both* x-ray safety training and radiological worker training [see 835.103 and 835.901].

15. Report to the XCO all *incidental* XGDs/XGFs that operate at an electron acceleration voltage greater than 40 kilovolts.

16. Ensure that processes are in place to identify, correct, or improve operations involving XGDs and XGFs.

1822 Requirements for Facility Managers

Facility managers shall do the following:

1. Approve, in consultation with RCT personnel supporting the facility management unit (FMU), the operation of subcontractor-owned XGDs within the FMU safety envelope delineated by the FMU authorization bases.

2. Ensure that all x-ray operations are fully described in any required, formal, FMU-facility-safety analysis/authorization basis documentation; such documentation will preclude unresolved safety questions (USQs) associated with conducting x-ray operations within the FMU.

1823 Requirements for the XGD and XGF Custodians

Guidance Note: Compiling and using an operational/maintenance logbook for each intentional XGD and XGF is strongly recommended. The benefits include documentation of actual XGD and XGF workload, performance, engineering control malfunction, and quality assurance checks.

XGD and XGF custodians shall do the following:

1. Provide guidance on implementing this chapter to facility managers and group leaders, including information on which workers require radiological worker training and/or x-ray safety training as a result of their need to handle or use radioactive materials in the course of x-ray operations [see 835.103 and 835.901].
2. Ensure that an HCP is compiled and approved by the safety- and environment-responsible line-management chain for each intentional XGD and XGF in accordance with the requirements contained in LIR300-00-02, "Documentation of Safe Work Practices" [see 835.104].
3. Ensure that an interlock/device warning light checklist is developed for interlock devices as part of each intentional XGD and XGF HCP and that this checklist is used to document the operability of interlocks and warning lights at least semiannually.
4. Ensure that a copy of the most recent radiation survey performed by the XCO on XGDs/XGFs owned by the group is posted at or near the operator control panel of the XGD and XGF.
5. Ensure that either the intentional XGD and XGF HCP designates the operators authorized to operate the specific XGD and XGF or that a separate authorized operator list is posted at or near the intentional XGD and XGF control panel.
6. When an XGD is no longer required, inform the XCO whether the XGD is intended to be disposed of as waste or whether it is intended to be transferred to a non-Laboratory entity. Ensure that XGDs to be disposed of meet the requirements contained in LIR404-00-02, "General Waste Management." **Guidance Note**: Refer to Article 1837 for more information on disposing of XGDs and other radiation-generating devices as excess property.
7. Ensure that SCRAM buttons installed within the XGF are operable and labeled as required.

   Guidance Note: SCRAM button safety devices may be labeled with the words "SCRAM button" or "Emergency OFF Switch,."

1824 Requirements for XGD and XGF Operators

XGD/XGF operators shall do the following:

1. Assist XGD/XGF custodians in compiling intentional XGD/XGF HCPs;
2. Check and document, at least semiannually, interlock/device warning lights of each intentional XGD/XGF that the XGD/XGF custodian has been authorized to operate;

   Guidance Note: XGD/XGF operators are encouraged to check the operation of intentional XGD/XGF interlocks/warning lights as often as necessary to become fully convinced that these safety devices are working; however, such checking need only be *documented* at least semiannually via the interlock/warning light checklist;

2. Operate only those intentional XGDs/XGFs authorized by the owning group leader in strict accordance with the XGD/XGF HCP; and
3. Immediately report to the owning group leader and XGD/XGF custodian any malfunction or misuse of the intentional XGD/XGF that may have compromised the XGD/XGF safety envelope.

1825 Subcontractor-Owned XGDs Used On-Site

The following steps shall be implemented as listed below for XGDs that are not Laboratory-owned, as defined by this chapter:

1. For subcontractor-owned XGDs, as defined by this LIR, the subcontractor shall notify the XCO whenever their XGDs are brought on-site.
2. The XCO shall coordinate with the subcontractor at the work site to ensure that the XGDs are under valid, current authorization, and that their use meets all Laboratory requirements.
3. The XCO shall obtain a copy of the subcontractor's state XGD authorization and shall write a memo to file stating that the subcontractor's XGD meets all state and federal requirements.
4. If the XGD does not meet all stated requirements, the subcontractor shall not be allowed to use the XGD on Laboratory property.

Part 3 Requirements for Support Organizations

1831 Requirements for the Procurement Group (BUS-5)

BUS-5 shall do the following:

1. Ensure that commercially available XGDs are purchased from approved vendors.
2. Ensure that all subcontracts involving the use of subcontractor-owned XGDs on Laboratory property specify that the subcontractor is responsible for notifying the XCO *when* its XGDs will be used on Laboratory property during the contract period. The XCO shall follow-up as specified in Article 1842, below.
3. Ensure that wording summarizing the requirements of Article 1835.1 through 1835.4 below, is placed into all subcontracts that might involve the use of *subcontractor-owned* XGDs on Laboratory property.

1832 Requirements for the ESH-12 XGD and the XGF Control Office (XCO)

The ESH-12 XCO shall so the following:

1. Serve as the office of record responsible for the master XGD and XGF database and central point-of-contact for DOE ESH inquiries regarding the Laboratory XGD and XGF radiological control program.
2. Perform radiation shielding design and evaluations of XGFs contingent upon request and funding from the FMU or group leader owning the XGF [see 835.1001(a)].
3. Provide guidance when requested by facility managers or group leaders on engineering controls, hazard control plans, interlocks, and other access controls associated with XGDs/XGFs.
4. Perform and document initial and periodic (typically annual) radiation surveys—in coordination with RCT personnel supporting the FMU—of all Laboratory-owned XGDs/XGFs, including incidental XGDs/XGFs [see 835.401(a)].
5. Initiate and coordinate with the responsible facility managers and group leaders the RWPs associated with the initial start-up and use of newly installed XGFs while the XGF HCP is being finalized.
6. Coordinate with the responsible group leaders in initiating and executing RWPs for on-site x-ray operations not otherwise covered by the XGD and XGF HCP.
7. Upon notification by facility managers or group leaders, perform and document radiation safety surveys of any Laboratory-owned XGD that has undergone refurbishment, modification, or upgrade in which (1) the primary radiation beam output may have increased; (2) the dimensions, energy, or primary x-ray beam orientation (direction) may have changed compared with the most recent survey; or (3) the engineered safety

systems—for example, interlocks, warning lights, exclusion fences, or shielding—may have been modified [see 835.401(a)(3)].

8. Direct that XGDs and XGFs not be used (that is, red-tagged) which either do not meet ANSI N43.2 or N43.3 safety requirements or for which more than 12 months have elapsed since the previous XCO radiation survey.

9. Upon notification from subcontractors that subcontractor-owned XGDs will be used on DOE property operated by Los Alamos, verify that the subcontractor XGD operating personnel meet training requirements and are authorized to use and possess their XGDs.

10. When requested by the facility manager or group owning intentional XGFs off-site, perform and document a radiation safety survey for such XGFs [see 835.401(a)].

11. If the XGD is to be transferred to a non-DOE entity, notify the responsible State Office of Radiological Control of the possible transfer of a formerly DOE-owned XGD to a non-Laboratory entity.

12. If the XGD is to be transferred to another DOE contractor, notify the DOE contractor's radiological control organization of the possible transfer of a formerly Laboratory-owned XGD transfer to another DOE contractor.

1833 Requirements for RCTs and Other Support Personnel for X-Ray Safety

RCTs and other x-ray safety support personnel shall do the following:

1. In coordination with FMs and group leaders, provide and maintain required radiological posting for XGDs and XGFs in accordance with chapter 7 of this LIR.

2. Provide radiological monitoring for x-ray operations involving radioactive materials [see 835.401(a)].

3. Assist group leaders and facility managers in overseeing the operation of subcontractor-owned XGDs within the FMU.

4. Assist group leaders owning XGDs that are to be disposed of by monitoring the XGD to determine whether or not it will be disposed of as radioactive waste.

1834 Requirements for the Health Physics Measurements Group (ESH-4)

ESH-4 shall do the following:

1. Provide calibration services traceable by NIST (National Institute of Standards and Technology) for x-ray detection and measurement instrumentation used for health and safety purposes at the Laboratory.

2. Evaluate and give to the XCO the exposure results of TLDs (thermoluminescent dosimeters) that are used in radiation safety surveys to document primary and scattered x-ray beam dose and dose rates.

3. Provide DOELAP (DOE Laboratory Accreditation Program) accredited external personnel dosimetry service to those XGD and XGF custodians and operators requiring such dosimetry under chapter 5 of this LIR.

1835 Requirements for the Hazardous Materials Response Group (ESH-10)

ESH-10 shall do the following:

1. Maintain the "Personnel Radiation Health and Safety During Field Radiography Operations" procedure and associated HCP [see 835.104];

2. Train and provide documentation of training to x-ray safety support personnel in using the above procedure/HCP [see 835.103];

3. Maintain a staff of personnel qualified to provide x-ray safety support for off-site x-ray operations;

4. Coordinate, as requested, x-ray safety support for Laboratory x-ray operations to be conducted off-site; and

5. Provide documentation to the XCO of x-ray safety surveys associated with the conduct of Laboratory x-ray operations off-site in accordance with the "Personnel Radiation Health and Safety During Field Radiography Operations" procedure and HCP [see 835.703(a)].

1836 Requirements for the ES&H Training Group (ESH-13)

ESH-13 shall maintain and provide the X-Ray Safety training course and document completion of the course for XGD custodians and operators through the EDS.

1837 Requirements for Disposing of Radiation-Generating Devices as Excess Property

1. Any device that intentionally or unintentionally generates ionizing radiation (for example, x-ray machines, D-T neutron generators, klystrons, and electron microscopes) must not be offered as excess property unless
   a. the item is considered a consumer product or laboratory device that is known not to produce harmful levels of ionizing radiation (for example, unaltered electron microscopes, CRT displays for computers, and televisions), or
   b. the item is being offered to an entity (for example, a university or research institute) that is fully aware of the hazards associated with the item and is capable of safely using the item by virtue of having an established health and safety program.
2. In either case, because of the complexity of interpreting whether an item meets these criteria, consult with the ESH-12 XGD/XGF (X-Ray Control) Office at 667-8085 to determine if the item can be offered as excess property. ESH-12 will then make the required notifications to the authorities who need to know about transferring the radiation-generating device to non-LANL entities as specified in Articles 1832.11 and 1832.12.

Part 4 References

Document Ownership—The Office of Institutional Coordination for this document shall be ESH-12.

Directory of Resources—ESH-12 XGD and XGF Control Office (XCO)

ANSI N43.2, "Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment"

ANSI N43.3, "American National Standard for General Radiation Safety—Installations Using Non-medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10 MeV"

DOE G441.5-1, Implementation Guide, "Radiation Generating Devices"

LIR300-00-01, "Safe Work Practices"

LIR404-00-02, "General Waste Management Requirements"

LPR402-00-00, "Worker Health and Safety"

Title 10 CFR, Part 835, "Occupational Radiation Protection"

Records—The ESH-12 XCO shall maintain all RWPs initiated by the XCO for XGDs/XGFs. It shall also maintain hard copy, auditable files of instrumented radiation safety surveys of Laboratory x-ray devices/facilities, including

- the date of the survey;
- x-ray device make/model/property number data;
- facility layout;
- implementation of existing radiation protection program elements, including required radiological posting/labeling;
- x-ray device/interlock characteristics;

- all relevant radiation levels associated with the normal operation of the x-ray facility, including radiation levels scattered to outdoor areas when applicable;
- primary x-ray beam radiation output, when the geometry of the x-ray system permits such a measurement, and any findings/recommendations of the survey; and
- specification of all radiation measurement instrumentation used in the survey.

The original copy of the survey report containing the above information shall be sent to the x-ray device/facility primary operator/x-ray custodian with an identical information copy to the group leader owning the x-ray facility and an information copy to ESH-1 personnel supporting that particular facility.

Appendix 18A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
X-Ray Generating Devices/Facilities Control	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals who are responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - Group leaders know about and approve of the XGDs/XGFs that they own. (Article 1821)
   - Group leaders request the XCO to provide radiation safety support to group-owned XGDs/XGFs. (Article 1821)
   - Workers who work *solely* with Class I XGDs/XGFs and who do not normally work with unsealed radioactive material need take only "X-Ray Safety" training; Radiological Worker training for such workers is not required. (Article 1821)
   - Facility managers shall fully describe FMU x-ray operations in any required safety analysis/authorization basis documents. (Article 1822.2)
   - XGD/XGF custodians shall ensure that an HCP is compiled and approved by the relevant group leader for each intentional XGD/XGF. (Article 1823.2)
   - XGD/XGF operators shall document the checking of XGD/XGF interlocks at least semiannually, only operate those XGDs/XGFs authorized by the group leader, and operate any authorized XGD/XGF in accordance with the HCP specific for the authorized XGD/XGF. (Article 1824)

Performance Assurance

Contents

Performance Assurance

Appendix 19A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

1911 General Requirements

The safety- and environment-responsible line-management chain shall ensure that the requirements specified in this chapter are implemented.

Part 2 Assessment Requirements

1921 Assessments

In this chapter, "assessment" shall be defined as the process of providing feedback to the safety- and environment-responsible line-management chain and the radiation protection organization on the effectiveness of the Radiation Protection Program.

1. **Guidance Note**: Observations, self-checks, inspections, verifications, self-assessments, and internal independent assessments are part of the numerous checks and balances needed in a good radiation protection program.

   Internal independent assessments (refer to LIR307-01-02, "Internal Independent Assessments") of the Radiation Protection Program shall be conducted over a 36-month period, addressing all functions [see 835.102]. The internal independent assessments shall address program performance, applicability, content, and implementation. These assessments shall be performed by the Internal Assessments Office (AA-2), with assistance from consultants internal and external to the Laboratory. **Guidance Note**: The time interval to conduct these internal, independent assessments may be extended by a period not to exceed 30 days to accommodate scheduling needs [see 835.3 (e)].

2. The following functions must be assessed within the 36-month period (10 CFR 835):

- management and administrative requirements
- internal and external exposure requirements
- personnel dosimetry and dose assessment (including nuclear accident dosimetry)
- portable and fixed instrumentation
- contamination control
- radiological monitoring (area and item monitoring)
- ALARA (as low as reasonably achievable) program
- accident and emergency dose controls
- radioactive material control, including sealed radioactive source control and material release
- entry controls
- training
- posting and labeling
- records and reports

- radiological design and administrative controls

3. Assessments shall use a "closed-loop" system; that is, action plans are developed, and corrective actions are taken and then verified for closure.

Part 3 Evaluation of Performance

Guidance Note: During the conduct of radiological work and the handling of radioactive materials, abnormal events could occur that indicate a weakness or area of programmatic breakdown of radiological controls.

Facts related to such events shall be promptly gathered to satisfy reporting and investigation requirements and, in a graded approach, to formulate corrective actions to prevent recurrence. **Guidance Note**: In addition, successful performance or completion of unique activities should be evaluated to identify and incorporate lessons learned. Analyzing the facts should reveal areas that can be improved or methods that can prevent the recurrence of undesired results.

1931 Notification and Reporting of Radiological Incidents by All Individuals

Guidance Note: A radiological incident is an unexpected event that takes place while radioactive materials or radiation-producing equipment are being used. Such incidents may have adverse effects on people, the environment, or facilities. The radiological incident report (RIR) provides a mechanism for (1) documenting incidents that may indicate a deficiency in the Laboratory's Radiation Protection Program; (2) tracking and trending these incidents; and (3) identifying radiological incidents that meet occurrence reporting criteria. Refer to LIR201-00-04, "Los Alamos National Laboratory Incident Notification Process," for radiological incident determination and notification requirements.

1932 Radiological Performance Measures

The safety- and environment-responsible line-management chain and workers shall be aware of the current UC/DOE contract Appendix F performance measures for occupational radiation protection ("Radiation Protection of Workers") and strive to manage and perform radiological work at the highest possible gradient for each measure.

1933 Post-Job Reviews

1. Performance shall be reviewed after special radiological work has been completed (see the glossary, Appendix U). If the actual doses fall outside the range of ± 25% of pre-job estimates, or if significant problems or successes were experienced, then perform and document a formal post-job review on improvements to optimize doses for similar future work.

2. **Guidance Note**: Post-job reviews should include reviews of the following:

   a. the total and individual doses compared to the pre-job estimates;

   b. the efficacy of the radiological controls implemented for the work;

   c. any adverse events affecting the work, such as skin contaminations, unexpectedly high individual exposures, or problems resulting from unnecessarily burdensome control requirements;

   d. conflicts between radiological safety requirements and other safety requirements;

   e. opportunities to improve performance or efficiency during repeated or similar work;

   f. significant differences between expected and actual radiological conditions or other issues affecting the work; and

   g. worker input regarding possible improvements in radiological safety practices for repeated or similar work.

Appendix 19A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Performance Assurance	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter have been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following.
Note: The article number is given with each bullet to help the reader find more information.

   - Internal, independent assessments of the Los Alamos National Laboratory Radiation Protection Program are conducted at least every 36 months. These assessments cover all functions listed in Article 1921.2 within the 36-month period. (Articles 1921.1 and 1921.2)
   - Corrective actions developed as a result of the independent assessment are verified to closure. (Article 1921.3)
   - When a radiological incident occurs, the actions and notifications delineated in Article 1931 must be carried out. (Article 1931)
   - The safety- and environment-responsible line-management chain and workers are aware of the current UC/DOE contract Appendix F performance measures for occupational radiation protection, and strive to manage and perform work at the highest possible gradient for each measure. (Article 1932)
   - Post-job reviews are conducted and documented after completion of special radiological work in which actual doses fall outside the range of ± 25% of pre-job estimates, or if significant problems or successes were experienced. (Article 1933)

Records and Reports

Contents

Records and Reports

Appendix 20A of this chapter (Guidance) presents the major criteria recommended for implementing the self-assessment.

Part 1 Introduction

2011 Purpose

This chapter prescribes requirements that shall be implemented for preparing and retaining radiological control records. Workers, the safety- and environment-responsible line-management chain, and the radiation protection organization shall use records to document radiological safety afforded to individuals on-site. Records of radiological control programs may be required to support worker health studies and future disputes or claims; therefore, these records shall be high quality, readily retrievable, and maintained for the prescribed period of time. Records shall be handled in such a way that personal privacy is protected.

2012 Records Management Program

1. A radiological records management program has been established at the Laboratory that, when implemented, shall ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable), and disposition. The records management program shall provide guidelines to ensure that records are maintained as required to document implementation of the requirements contained in 10 CFR 835 [see 835.701(a)]. These records shall include
   a. Radiation Protection Program documents (Laboratory-wide and specific to line organizations and ESH groups);
   b. individual radiological doses;
   c. personnel training (course records and individual records);
   d. ALARA (as low as reasonably achievable) program implementation;
   e. radiological instrumentation test, maintenance, and calibration;
   f. personnel-monitoring-device testing, maintenance, and calibration;
   g. radiological surveys;
   h. area monitoring dosimetry results;
   i. radiological work permits;
   j. radiological performance indicators and assessments;
   k. documentation of quality assurance activities;
   l. radiological incident reports;
   m. sealed radioactive source accountability and control;
   n. release of material records;
   o. radiological safety reviews of facility designs, controls, and operations; and
   p. x-ray device/facility survey reports.
2. Detailed information concerning an individual's exposure shall be made available to that individual, upon request, consistent with the Federal Privacy Act of 1974 and the State of California Information Practices Act of 1977, which requires that the privacy of individual records be protected [see 835.702(f) and 801(d)].
3. Care shall be exercised to ensure that records generated in response to the requirements of this LIR are not classified, or are properly reviewed, marked, and protected.

2013 Radiological Units

Unless otherwise specified, radiological control records shall use the special units of curie, roentgen, rad, and rem, including multiples of these units [see 835.4].

Part 2 Employee Records

2021 Employment History

For each worker whose occupational exposure is monitored in accordance with Article 521.1.a through c and e, or 522.1 through 3, efforts must be made to obtain records of previous years' occupational doses (see Article 2022.10). If formal records of previous occupational exposure cannot be obtained, a written estimate signed by the individual shall be accepted [see 835.702(e)].

2022 Personnel Radiological Records

1. Individual monitoring records shall be maintained to demonstrate conformance to the regulatory limits [see 835.701(a)].
   a. Documentation of all occupational doses received during the current year, except for doses resulting from planned special exposures conducted in accordance with Part 3 of chapter 4 and for emergency exposures authorized in accordance with Part 3 of chapter 2, shall be obtained and included in the individual's dose record to demonstrate compliance with the occupational dose limits specified in Table 4-1, chapter 4 [see 835.702(d)].
   b. Records of doses received by all individuals for whom individual monitoring was performed as required by Article 521 or 522 (chapter 5), including records of zero dose, shall be maintained [see 835.702(a)].
   c. These records shall be detailed enough to evaluate conformance to all applicable dose limits and monitoring and reporting requirements [see 835.702(c)(1) & (2)].
   d. The results of individual external and internal dose monitoring that is performed, but not required by Article 521 or 522 (chapter 5), shall also be recorded [see 835.702(b)].
2. Records associated with individuals, including radiation dose records [see 835.702(c)(2)], shall contain, at a minimum, the following identifying information:
   a. individual's name,
   b. individual's z-number or other unique identification number,
   c. relevant dates for monitoring or reporting periods covered, and
   d. the host Laboratory organization for that period.
3. Procedures, data, and supporting information required to reconfirm an individual's dose at a later date shall be maintained [see 835.702(g)].
4. External dose records shall include extremity, skin, lens of the eye, and whole-body dose monitoring results [see 835.702(c)(3)]. **Guidance Note**: These doses are usually measured with personnel dosimeters, but records may include the following:
   a. evaluations resulting from anomalous dose results such as unexpected high or low doses;
   b. dose reconstruction from lost or damaged dosimeters, or for unbadged workers; and
   c. evaluations of non-uniform radiation doses.
5. Internal dose records shall include committed effective dose equivalent [see 835.702c(4)(i)], committed doses to the affected organs and tissues [see 835.702(c)(4)(ii)], and identity of radionuclides [see 835.702(c)(4)(iii)]. **Guidance Note**: The supporting information typically includes the following:
   a. whole-body and lung counting results (including measurements of chest-wall thickness, if necessary);
   b. urine, fecal, and specimen analysis results, including estimated intake; and

c. dose assessment, as required.

6. Records of the summation of external dose and committed dose equivalent to any organ receiving a reportable dose shall be maintained for the individual receiving such dose [see 835.702(c)(5)(ii)].

7. The total effective dose equivalent received by each individual monitored in accordance with Article 521 or 522 (chapter 5) shall be maintained for each year the individual is monitored [see 835.702(c)(5)(i)].

8. The dose equivalent to the embryo/fetus of a declared pregnant worker shall be maintained [see 835.702(c)(6)]. Written declarations of pregnancy, including the estimated date of conception, and revocations of declarations of pregnancy shall be maintained [see 835.704.d].

9. Individual dose records shall include the cumulative total effective dose equivalent [see 835.702(c)(5)(iii)]. The cumulative total effective dose equivalent shall include all occupational dose received by the individual at Los Alamos National Laboratory, at other sites, and from previous employers, beginning January 1, 1989.

10. Efforts shall be made to obtain records of previous years' doses for each radiological worker monitored in accordance with Article 521.1.a. through c and e or 522.1 through 3 (chapter 5) [see 835.702(e)]. If an individual's previous employer does not respond to initial efforts to obtain these records, two additional attempts shall be made.

11. Authorized emergency doses and planned special exposures [see 835.204 and 1302] shall be accounted for separately, but must be maintained with the individual's occupational dose records.

12. Recording non-uniform dose to the skin shall not be required if the dose is less than two percent of the limit specified for the skin in Table 4-1, chapter 4, [see 835.702(b)]. (See Article 2071.4 for requirements for records of radiological incidents and occurrences.)

13. Occupational exposure received at sites external to the Laboratory shall be included in the dosimetry record.

2023 Other Personnel Radiological Records

Records of the formal written declaration of pregnancy, including the estimated conception date, and revocations of declarations of pregnancy shall be maintained [see 835.704(d)]. **Guidance Note**: Records indicating that the pregnancy has concluded (therefore, the conditions of Article 424, chapter 4, no longer apply) should also be maintained.

2024 Radiological Training and Qualification Records

1. Personnel training records shall be controlled and retained [see 835.704(a)].

2. Records shall be retained for the following types of radiation safety training [see 835.704(a)]:

   a. general employee radiological training,

   b. radiological worker training,

   c. RCT training,

   d. members of the public training for unescorted access, and

   e. institutional hazard-specific training.

3. Records shall be maintained as required (refer to Article 851, chapter 8) to demonstrate that individuals who are responsible for developing and implementing measures required to ensure implementation of 10 CFR 835 requirements have the required education, training, and skills to execute these responsibilities [see 835.103 and 835.701(a)].

Part 3 Radiological Control Procedures

2031 ALARA Program Records

Records of actions taken to maintain occupational exposures ALARA shall be maintained [see 835.701(a)]. These records shall include facility design and control measures [see 835.704(b)].

2032 Quality Assurance Records

Records of quality assurance reviews and audits developed for radiological control functions shall be retained to ensure that enough records are specified, prepared, reviewed, approved, and maintained to accurately reflect completed work [see 835.704(c)]. **Guidance Note**: DOE Order 414.1, "Quality Assurance," and 10 CFR 830.120 provide additional information regarding quality assurance records.

Part 4 Radiological Monitoring

2041 Area Monitoring Records

1. Radiological control programs shall include monitoring for radiation, airborne radioactivity, and contamination to determine existing conditions in a given location.

2 Records shall be maintained to document the

a. results of monitoring and surveys for radiation and radioactive materials [see 835.703(a)];

b. results of monitoring and calculations used to determine individual occupational exposures [see 835.703(b)];

c. results of surveys for release of materials from radiological areas [see 835.703(c)] and other areas controlled for contamination;

d. results of sealed-radioactive-source leak tests and inventories [see 835.704(f)];

e. results of surveys of radioactive material packages received from transportation [see 835.405 and 701(a)]; and

f. changes in monitoring equipment, techniques, and procedures [see 835.704(e)]. Health Physics Operations (ESH-1), Health Physics Measurements (ESH-4), and Radiation Protection Services (ESH-12) shall maintain as records previous versions of those documents related to equipment, techniques, and procedures used for monitoring areas and individuals in facilities as well as outside facilities, including routine monitoring instructions (RMIs)

2042 Radioactive Sealed Source (RSS) Leak Tests and Inventories

1. The ESH-12-maintained LRACs database shall be the official, archived repository of all records pertaining to RSS accountability and control. LRACs shall electronically archive records to include leak test and inventory results of accountable RSSs, GCs containing RAM, machine neutron generators, and embedded RSSs [see 835.704(f) and 835.1202(a)]. The LRACs database shall suffice as the official record for

a. the physical location of each accountable sealed radioactive source,

b. verification that associated postings and labels are serving their purpose,

c. verification that storage locations, containers, and devices are serving their purpose, and

d. verification of the performance of and results of the leak test.

Part 5 Instrumentation and Calibration Records

2051 Calibration and Operational Checks

1. Calibration records for fixed, portable, and laboratory radiation measuring instruments and equipment and individual monitoring devices shall be maintained by ESH-4 in accordance with their records management requirements [see 835.703(d)].

2. Calibration and maintenance records shall be maintained by ESH-4, Engineering Sciences and Applications (ESA) Measurements Technology Group, and the support service subcontractor in accordance with their records management requirements for instruments and equipment used for monitoring [see 835.703d].

   Guidance Note: This would not include battery, cable, and some types of window (Mylar windows on air proportional probes) replacements performed by ESH-1 in the field.

3. Documentation of instrument operational checks shall be maintained [see 835.701(a) and 835.401(b)(4)].

4. Maintenance results for each instrument and device shall be documented and retained [see 835.703(d)].

Part 6 Records Management

2061 Retaining Records

1. Records (for example, radiation status of facility and personnel) shall be retained throughout the life of the Laboratory and then transferred to the cognizant federal oversight agency, unless other disposition is authorized by such agency [see 835.702(h)]. The records that shall be maintained throughout the life of the Laboratory include the following:

   a. dosimetry data required to allow future verification or reassessment of the recorded doses for all personnel who have participated in the dosimetry program;

   b. radiation survey data;

   c. training program descriptions and attendance records;

   d. unusual occurrences of operational failures;

   e. significant revisions to equipment, techniques, and procedures used for radiological control of the workplace;

   f. RCT (radiological control technician) logbooks;

   g. ALARA documentation; and

   h. declarations and revocations of pregnancy.

2. Records associated with performance assessment activities shall be maintained through two audit cycles to establish a baseline and trending with respect to improving conformance with the requirements found in this LIR and other radiation protection program requirements. Final internal assessment reports shall be maintained by AA-2 in accordance with their records management requirements. IM-5, the Information and Records Management Group, shall then maintain these reports through the life of the Radiation Protection Program and transfer them to the cognizant federal oversight agency until other disposition is authorized by such agency [see 835.701(b), 835.704(c)].

3. Other radiation protection records shall be maintained by the organization that generated the records in accordance with their records management requirements. These records shall then be archived in accordance with the records retention schedules established by IM-5.

Part 7 Radiological Reporting

2071 Reporting to Individuals

1. Individuals who are monitored in accordance with Article 521 or 522 (chapter 5) shall be given an annual report of their dose [see 835.801(c)]. Upon request, an individual shall be given detailed information concerning his or her exposure, consistent with the Privacy Act [see 835.801(d)].

2. Upon request, employees who are terminating shall be given a report, as soon as data are available but not later than 90 days following the last day of employment. A written estimate, based upon available information, shall be provided upon termination, if requested [see 835.801(b)].

3. Reports of individual doses shall include the site or facility name, the individual's name and social security number, z-number, or other unique identification number, and all dose information required by Article 2022 above [see 835.801(a)].

4. Copies of the individual dose information contained in reports of individual exposure to radiation or radioactive material required under DOE 232.1 or as a result of a planned special exposure, emergency exposure, or accident shall be given to the affected individual at a time not later than transmittal of the report to the Department [see 835.801(e)].

Appendix 20A
Recommended Major Implementation Criteria for Self-Assessment (Guidance)

Chapter Title	LIR Number
Records and Reports	LIR402-700-01.0

1. The most important criterion for assessing the implementation status of this chapter is knowing whether the requirements described in the chapter been communicated to the individuals responsible for performing the work.

2. The recommended major implementation criteria for self-assessment of this chapter are the following. *Note: The article number is given with each bullet to help the reader find more information.*

   - Radiological control records use the special units of curie, roentgen, rad, and rem, including multiples of these units. (Article 2013)
   - For each worker who is monitored in accordance with the requirements of Article 521.a through c, or 522.1 through 3, efforts are made to obtain records of previous years' occupational doses. (Article 2021)
   - Individual monitoring records are maintained to demonstrate compliance with the regulatory limits. (Article 2022.1)
   - Records associated with individuals, including radiation dose records, contain at least the information listed in Article 2022.2. (Article 2022.2)
   - Dose quantities required by Article 2022 are maintained in the individual's dose record (Article 2022).
   - Authorized emergency doses and planned special exposures are accounted for separately from the individual's occupational dose, but must be maintained with the individual's occupational dose records (Article 2022.11).
   - Occupational exposures received at sites external to the Laboratory are included in the individual's dosimetry record. (Article 2022.13)
   - Records of the formal written declaration of pregnancy, including the estimated conception date, and revocations of declarations of pregnancy are maintained. (Article 2023)
   - Personnel radiation safety training records are maintained. (Article 2024.1)
   - Records are maintained to demonstrate that individuals who are responsible for the development and implementation of measures necessary to ensure compliance have the education, training, and skills to execute these responsibilities. (Article 2024.3)
   - ALARA program records are maintained. (Article 2031)
   - Records of quality assurance reviews of radiation protection functions are maintained. (Article 2032)
   - Radiation protection monitoring records are maintained. (Article 2041)
   - Records of the inventory and leak testing of accountable sealed radioactive sources are maintained and include the information specified in Article 2042. (Article 2042)
   - Calibration and maintenance records for instruments and equipment used for radiation protection monitoring are maintained. (Article 2051)
   - Records listed in Article 2061.1 are retained throughout the life of the Laboratory and are then transferred to the cognizant federal oversight agency. Other radiation protection records are maintained in accordance with the records retention schedules established by IM-5. (Article 2061.1)
   - Individuals monitored in accordance with Article 521 or 522 are given an annual report of their dose. (Article 2071.1)

abnormal situation—Unplanned event or condition that adversely affects, potentially affects, or indicates degradation in the safety, security, or environmental or health protection performance or operation of a facility.

acceptable knowledge (AK)—A method used in lieu of or in conjunction with sampling and analysis to characterize materials and items through knowledge of (1) origin, (2) processes involved, (3) storage, (4) use of materials, and (5) segregation. The method may include supplemental waste analysis data, and facility records or analysis as applied to waste characterization.

accelerator—See *nonmedical accelerator facility*.

accessible RSSs—RSSs (see definition below) that are located in routinely used work areas approved for the conduct of normal RSS work.

Accident Response Group (ARG)—A group formed by DOE to respond to nuclear accidents/incidents.

accountable RSS—A sealed radioactive source with a half-life equal to or greater than 30 days and an isotopic activity equal to or greater than the corresponding value provided in Appendix A of chapter 16; also GCs containing RAM, regardless of the amount of radioactivity contained in the GC, and any machine neutron generator as defined in this LIR.

accuracy—The degree of agreement of the observed value with the true or correct value of the quantity being measured.

activation—The process of producing a radioactive material by bombardment with neutrons, protons, or other nuclear particles.

active RSS storage area—A designated, secure, storage location for RSSs, physically separate from a "long-term RSS storage area," wherein RSSs are stored and secured when not in routine use.

acute exposure—The exposure to a relatively large amount of radiation (or intake of radioactive material) over a short period of time, such as an hour or a day.

airborne radioactive material or airborne radioactivity—Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

airborne radioactivity area—Any accessible area where (1) the concentration of airborne radioactivity—above natural background—exceeds or is likely to exceed the derived air concentration (DAC) values listed in Appendix A or Appendix C of 10 CFR 835, November 4, 1998; or (2) an individual without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.

air-line respirator or supplied-air mask—A full-face respirator that supplies air to the wearer through a hose from a compressor or a separate compressed-air cylinder.

air-purifying respirator—A full-face respirator equipped with replaceable HEPA, chemical, or combination cartridge(s).

AK—acceptable knowledge

ALI—annual limit on intake

ambient air—General air in the area of interest (e.g., the general room atmosphere) as distinct from a specific stream or volume of air that may have different properties.

American National Standards Institute (ANSI)—An organization that has formulated and published national voluntary consensus-type radiation safety standards in the form of ANSI N43.3 and ANSI N43.6.

analytical XGD—A type of intentional XGD consisting of local and remote components that use intentionally produced x-rays to evaluate—typically through x-ray diffraction or fluorescence—the phase state, surface characteristics, and/or elemental composition of various materials. **Guidance Note**: Local components include those that are struck by x-rays, such as the x-ray source housing, beam ports, shutter assemblies, collimators, sample holders, cameras, goniometers, detectors, and shielding. Remote components include power supplies, transformers, amplifiers, readout devices, and control panels.

annual limit on intake (ALI)—Derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rem (0.05 sievert) or a committed dose equivalent of 50 rem (0.5 sievert) to any individual organ or tissue. **Guidance Note**: ALI values for intake by ingestion and inhalation of selected radionuclides are based on Table 1 of the US Environmental Protection Agency's Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," published September 1988.

ANSI—American National Standards Institute

area—For purposes of radiological control, a space is considered an area (and would be posted as an *area*) if it is accessible to an individual and that individual could receive a whole-body exposure (extremities are not considered whole body). However, containment devices such as glove boxes, hoods, or open-front boxes would not be posted as *areas* for radiological purposes unless an individual were to enter them.

ARG—Accident Response Group

as low as reasonably achievable (ALARA)—An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels that are as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. **Guidance Note**: As used in this LIR, ALARA is not a dose limit but a process that has the objective of attaining doses that are as far below the applicable controlling limits as is reasonably achievable.

assessment—Evaluating or appraising a process, program, or activity to determine its acceptability.

attenuation—Reducing a radiation quantity upon passage of the radiation through matter resulting from all types of interaction with that matter.

background—Radiation from the following sources:

(1) naturally occurring radioactive materials that have not been technologically enhanced,

(2) cosmic sources,

(3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices),

(4) radon and its progeny in concentrations or levels (existing in buildings or the environment) that have not been elevated as a result of current or previous activities, and

(5) consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.

barrier—An obstruction that prevents access to an area where high dose rates may exist.

becquerel (Bq)—The International System (SI) unit of radioactivity. One becquerel is the quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second.

best available technology (BAT)—The preferred technology for treating a particular process liquid waste, selected from among others after taking into account factors related to technology, economics, public policy, and other parameters. **Guidance Note**: As used in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," BAT is not a specific level of treatment, but the conclusion of a selection process that includes several treatment alternatives.

bioassay—Determining the kinds, quantities, or concentrations and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis and evaluation of radioactive materials excreted or removed from the human body.

cabinet XGD—A type of intentional XGD in which the x-ray tube is installed in an enclosure (cabinet) which, independent of existing architectural structures except the floor upon which it may be placed, is intended to (1) contain at least that portion of a material being irradiated, (2) provide radiation attenuation, and (3) exclude individuals from its interior during x-ray generation. Included in this definition are all XGDs designed primarily for inspecting carry-on baggage at airline, railroad, and bus terminals or similar XGDs used to radiologically inspect items before entry into a nuclear facility. **Guidance Note**: Not included in this definition are XGDs that use a building wall for shielding and XGDs that use portable shields on a temporary basis. Cabinet XGDs are certified as such by the Food and Drug Administration under 21 CFR 1020.40.

calibration—Adjusting and/or determining either one of the following:

(1) responding to or reading an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values, or

(2) the strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.

CAM (continuous air monitor) alarm—CAM alarms include actuation of audible and visible indications, including both trouble type alarms and alarms indicating airborne radioactivity.

certification—Formally documented, auditable, quality assurance process by which LANL management is assured that employees have the requisite skills, knowledge, and abilities to perform their assigned duties. Certification is an official endorsement that an employee meets all criteria established by DOE orders and/or other external agencies.

CFR—Code of Federal Regulations

check source—A radioactive source, not necessarily calibrated, that is used to confirm the continuing satisfactory operation of an instrument.

chronic exposure—The exposure to relatively low levels of radiation (or intake of radioactive materials) over a long period of time (that is, over a lifetime).

class I XGF—An XGF in which, on the protective side of the shielding surrounding the XGD, the operator is exposed to a radiation dose rate that is less than 0.5 mrem in any one hour measured 2 inches (5 cm) from the outer shielding surface. Radiation shielding surrounding the XGD must be permanent (nonremovable), and any interlocks must not be capable of being overridden. Examples of such low-hazard class I XGFs include most incidental XGDs; intentional XGFs determined to be "exempt shielded" and "unattended" installations under ANSI N43.3; cabinet XGDs; and enclosed-beam analytical XGDs.

class II XGF—An XGF whose radiation output and degree of use create a realistic potential for the operator, on the protective side of the shielding surrounding the XGD, to be exposed to a radiation dose rate greater than 100 mrem in one year, but less than or equal to 25 mrem in any work week evaluated one foot (30 cm) from the outer shielding surface. Such facilities have interlocks similar to class I facilities; however, the shielding typically is not as extensive. Examples of XGFs that do not normally exceed these operator dose rate limits include "open-beam" analytical XGDs and many intentional XGFs, defined below.

class III XGF—An XGF whose radiation output and degree of use create a realistic potential for the operator, on the protective side of the shielding surrounding the XGD, to be exposed to a radiation dose rate greater than or equal to 25 mrem in any work week evaluated one foot (30 cm) from the outer shielding surface. In the absence of any dedicated radiation shielding surrounding the XGD (e.g., portable XGDs used outdoors), the emission limit of greater than 25 mrem in any work week shall be evaluated one foot (30 cm) from the exterior surface of the XGD tube housing. Examples of Class III XGFs are "open" intentional XGD installations and some incidental XGDs.

collimator—Device used to limit the size, shape, and direction of the primary XGD beam.

commingling area—An area where personnel wearing anti-c clothing and personnel wearing personal clothing or work clothing used in uncontrolled areas may come into contact with each other.

containment device—Barrier such as a glove bag, glove box, or tent for inhibiting the release of radioactive material from a specific location.

contamination—Deposition of radioactive material anywhere it is not desired, particularly where its presence may be harmful.

contamination area—Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Table 14-1, but do not exceed 100 times those values.

contamination survey—Use of smears, swipes, or direct instrument surveys to identify and quantify radioactive material on personnel, on equipment, or in areas.

continuous air monitor (CAM)—An instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels. Also known as a real-time air monitor.

contractor—Any entity under contract with the Department of Energy with the responsibility to perform activities at a DOE site or facility.

controlled area (same as radiological controlled area)—Any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material.

critical mass—The smallest mass of fissionable material that will support a self-sustaining chain reaction under specified conditions.

criticality—See *nuclear criticality*.

critique—Meetings of personnel involved in or knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts.

DAC—derived air concentration

DCG—derived concentration guide

declared pregnant worker—A woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational dose limits to the embryo/fetus as provided at Table 4-1. This declaration may be revoked, in writing, at any time by the declared pregnant worker.

decontamination—Process of removing radioactive contamination and materials from personnel, equipment, or areas.

Department of Transportation (DOT)

depleted uranium (DU)—Uranium that is almost exclusively U-238 because the naturally occurring isotope U-235 has been extracted.

derived air concentration (DAC)—For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3). For radionuclides listed in Appendix C of 10 CFR 835, the air

immersion DACs were calculated for a continuous, nonshielded exposure via immersion in a semi-infinite atmospheric cloud. **Guidance Note**: The values are based on the derived airborne concentration found in Table 1 of the US Environmental Protection Agency's Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," published September 1988.

derived air concentration-hour (DAC-hour)—The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to that radionuclide, in hours.

derived concentration guide (DCG)—The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (that is, ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem *or* 0.1 rem (1 mSv). **Guidance Note**: DCGs do not consider decay products when the parent radionuclide is the cause of the exposure (DCG values are presented in chapter III of DOE Order 5400.5) (1 rem = 0.01 sievert).

detection limit—The extreme of detection or quantification for the radiation of interest by the instrument as a whole or an individual readout scale. **Guidance Note**: The *lower detection limit* is the minimum quantifiable instrument response or reading. The *upper detection limit* is the maximum quantifiable instrument response or reading.

detector—A device or component that produces an electronically measurable quantity in response to ionizing radiation.

direct survey—Quantitative survey for detecting the presence of both removable and fixed contamination (total contamination) on a surface. **Guidance Note**: This test is normally performed by either holding or slowly moving a portable survey instrument detector over a surface and counting the radioactive emissions from the total contamination residing on the surface.

disintegration per minute (dpm)—The rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

division training generalist (DTG)—An individual who acts as the organizational unit's primary point of contact for the Laboratory-wide training groups and facility-training contacts.

DOE—Department of Energy

DOE activity—An activity taken for or by DOE in a DOE operation or facility that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. **Guidance Note**: The activity may include design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and operations, possibly including an entire site or multiple DOE sites.

DOELAP—DOE Laboratory Accreditation Program; a program that accredits external dosimetry and internal dose assessment programs to DOE standards.

dose—a general term for absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined in this glossary.

DU—depleted uranium (see definition on page 4).

The following section contains definitions of dose terms that are used for various exposure calculations and record-keeping purposes:

absorbed dose (D)—The energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

collective dose—The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

committed dose equivalent ($H_{T,50}$)—The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert).

committed effective dose equivalent ($H_{E,50}$)—The sum of the committed dose equivalents to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate weighting factor (W_T) - **that is** $H_{E,50} = W_T H_{T,50}$. Committed effective dose equivalent is expressed in units of rem (or sievert).

cumulative total effective dose equivalent—The sum of all total effective dose equivalent values recorded for an individual, where available, for each year occupational dose was received, beginning January 1, 1989.

deep dose equivalent—The dose equivalent derived from external radiation at a tissue depth of 1 cm in tissue.

dose equivalent (H)—The product of the absorbed dose (D) (in rad or gray) in tissue, a quality factor (Q), and all other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

effective dose equivalent (H_E)—The summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factor (W_T)—that is, ($H_E = W_T H_T$). It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this LIR, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures. The effective dose equivalent is expressed in units of rem (or sievert).

external dose or exposure—The portion of the dose equivalent received from radiation sources outside the body (i.e., “external sources”).

gray (Gy)—SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

internal dose or exposure—That portion of the dose equivalent that is received from radioactive material taken into the body (e.g., “internal sources”).

lens-of-the-eye dose equivalent—The external exposure of the lens of the eye; taken as the dose equivalent at a tissue depth of 0.3 cm.

quality factor (Q)—The modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor.

The quality factors to be used for determining dose equivalent in rem shall be as follows:

Radiation Type	Quality Factor
X-rays, gamma rays, positrons, electrons (including tritium beta particles	1
Neutrons, 10 keV	3
Neutrons, >10 keV	10
Protons and singly-charged particles of unknown energy with rest mass greater than one atomic mass unit	10
Alpha particles and multiple-charged particles (and particles of unknown charge) of unknown energy	20

When spectral data are insufficient to identify the energy of the neutrons, a quality factor of 10 shall be used. When spectral data are sufficient to identify the energy of the neutrons, the following mean quality factors may be used:

Quality Factors for Neutrons

Neutron Energy (MeV)	Mean Quality Factor	Neutron Flux Density ($cm^{-2}s^{-1}$)
2.5×10^{-8} thermal	2	680
1×10^{-7}	2	680
1×10^{-6}	2	560
1×10^{-5}	2	560
1×10^{-4}	2	580
1×10^{-3}	2	680
1×10^{-2}	2.5	700
1×10^{-1}	7.5	115
5×10^{-1}	11	27
1	11	19
2.5	9	20
5	8	16
7	7	17
10	6.5	17
14	7.5	12
20	8	11
40	7	10
60	5.5	11
$1x10^2$	4	14
$2x10^2$	3.5	13
$3x10^2$	3.5	11
$4x10^2$	3.5	10

rad—Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram 1 (0.01 gray).

rem—Unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor, and any other necessary modifying factor (1 rem = 0.01 sievert).

shallow dose equivalent—The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

sievert (Sv)—SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rem).

total effective dose equivalent (TEDE)—The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

weighting factor (W_T)—The fraction of the overall health risk, resulting from uniform, whole-body irradiation, attributable to specific tissue (T). The dose equivalent to tissue (H_T) is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue. (Refer to Appendix 4A for the weighting factors.)

whole body—For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.

End of special terms for "dose."

dose assessment—Process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.

DOT—Department of Transportation

dosimeter—A device for measuring and registering radiation dose.

dosimetry—The measurement of radiation doses.

embedded RSS—A small-activity RSS intentionally installed in a radiation measurement instrument at the time of manufacture that is *not* intended to be removed or adjusted by the instrument user and which provides internal calibration, standardization, or functional checking of the instrument. **Guidance Note**: Some liquid scintillation counters, beta/gamma radiation area monitors, tritium monitors, and process equipment contain embedded RSSs.

embryo/fetus—Developing human organism from conception to birth (same as "unborn child"). ◘

emergency off switch—See "SCRAM button" below.

Employee Development System (EDS)—A database that documents each LANL employee's job-related training.

enclosed-beam analytical XGD—An analytical XGD in which all possible x-ray paths (primary as well as diffracted beams) are fully enclosed and which meets the radiation safety requirements specified in ANSI N43.2 (referenced in chapter 18, Part 3).

energy dependence—A change in instrument response with respect to radiation energy for a constant exposure or exposure rate.

engineering controls—Use of components and systems to reduce dose and airborne radioactivity and the spread of contamination by using piping, containment devices, ventilation, filtration, or shielding.

entrance or access point—Any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

Environment, Safety, and Health Division—ESH Division

escort (qualified escort)—an individual who has current radiological training for the area to be entered by the escorted individual and who ensures that the escorted individual implements the requirements of the LANL Radiation Protection Program for the area to be entered.

escorted individual—An individual who is accompanied by another individual who has current radiological training for the area being entered. The trained individual (that is, the escort) has direct verbal control of the individual being escorted and is in reasonably close physical proximity to the individual.

exempt shielded intentional XGF installation—An intentional XGF that meets the radiation safety requirements specified in ANSI N43.3 (referenced in chapter 18, Part 3) and that provides such a high degree of protective shielding to the operator that individual dosimetry is generally not necessary.

exposure—Being exposed to *ionizing radiation* or to radioactive material.

external radiation—an ionizing radiation (gamma, x-ray, beta, alpha, neutron) field created by radioactive material or a radiation-producing device external to the human body.

extremity—Hands and arms below the elbow or feet and legs below the knee.

facility—A facility includes systems, buildings, utilities, and related activities whose use is directed to a common purpose at a single location. Examples include accelerators, storage areas, nuclear reactors, radioactive waste disposal systems, testing laboratories, and research laboratories.

facility manager (FM)—A person responsible for the delineation, maintenance, and management of the safety envelopes of the major facilities located within the geographical boundaries of the facility management unit (FMU).

fail-safe—A term applied to devices that, in their most likely "single point" failure modes, fail in a manner that mitigates the hazard. Also a device design in which all credible failure modes of x-ray system indicator or radiation safety components results in a condition in which individuals are intrinsically safe from exposure to x-rays. **Guidance Note**: Such a design may cause beam port shutters to close, primary transformer electrical power to be interrupted, or otherwise prevent the production of x-rays upon failure of the safety or warning device.

filter integrity test—Test performed on High-Efficiency Particulate Air (HEPA) filters to identify any damage to the filter or leakage around the filter.

fissile material—Any material fissionable by *thermal* (slow) neutrons. The three primarily fissile materials are U-233, U-235, and Pu-239.

fissionable material—Any material fissionable by *thermal* (slow) or fast neutrons. Radionuclides such as U-238 are fissionable by fast neutrons.

five-step approach to safety—Part of the safety culture for performing work that comprises five elements—defining the scope of work, analyzing the hazards, developing and implementing controls, performing work, and using feedback to identify improvement opportunities.

fixed contamination—Contamination that can only be removed from surfaces by destructive means (such as grinding or chipping). For posting purposes, fixed contamination exceeding Table 14-1 limits are of concern.

FM—facility manager

FMU—facility management unit

frisk or frisking—Process of monitoring personnel for contamination. **Guidance Note**: Frisking can be performed with a hand-held survey instrument, automated monitoring device or by a radiological control technician.

GC—gas chromatograph, an apparatus used to (1) detect and identify certain chemically volatile compounds, (2) determine certain physical properties of such compounds, and/or (3) isolate components or fractions of certain complex compounds.

general employee—A DOE or DOE subcontractor employee; an employee of a subcontractor to a DOE contractor; or an individual who performs work for or in conjunction with DOE or uses DOE facilities.

geotropism—A change in instrument response with a change in instrument orientation as a result of gravitational effects.

gestation period—The time from conception to birth, approximately nine months in a human being.

GPHS—General purpose heat source. A device containing SNM, the radioactive decay heat from which heat is provided to nearby assembly components.

hazard control plan (HCP)—A document that at a minimum defines the work, identifies the hazards associated with the work, and describes the controls needed to reduce the risk posed by the work to an acceptable level.

HCP—hazard control plan

health physics technician (HPT)—A worker who has completed portions of the Radiological Control Technician (RCT) training but has not become fully qualified.

HEPA —high-efficiency particulate air filter

hermetically sealed—Sealing an item with an air tight or impermeable barrier, so that it has no potential for internal contamination.

High Contamination Area—Any accessible area where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Table 14-1.

High Radiation Area—Any accessible area where radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

high-activity RSS—An RSS (see definition below), typically in the "tens of Curies" activity range or greater, that is used as a radiation source for field radiography operations or used to provide intense irradiation of biological or industrial materials. **Guidance Note**: Such high-activity gamma-emitting RSSs fall under the purview of ANSI N43.3.

high-efficiency particulate air (HEPA) filter—Throwaway extended pleated medium dry-type filter with (1) a rigid casing enclosing the full depth of the pleats, (2) a minimum particle removal efficiency of 99.97 percent for thermally generated monodispersed di-octyl phthalate smoke particles with a diameter of 0.3 micrometer, and (3) a maximum pressure drop of 1.0 inch water gauge (w.g.) when clean and operated at its rated airflow capacity.

hot job exclusion area (HJEA)—A temporary area established around an unknown condition in the event of a radiological incident or an operation that is expected to increase the potential for contamination and/or personnel exposure because of the nature of the operation (hot job).

hot particle—A "hot particle" is a small, loose, highly radioactive particle with an activity greater than 15,000 disintegrations per minute and/or capable of producing a shallow dose equivalent greater than 100 mrem in 1 hour.

HP—health physicist

immediately dangerous to life or health (IDLH)—Atmospheres containing either (1) less than 19.5 % oxygen by volume or (2) air concentrations of toxic or radioactive contaminants that pose an immediate threat to life or produce immediate, irreversible, debilitating health effects.

inaccessible RSSs—RSSs (see definition below) located in areas that are difficult or dangerous to access. Examples of inaccessible RSSs include an RSS located at the top of a tall tower or an RSS located in an oxygen deficient atmosphere or in a Very High Radiation Area. **Guidance Note**: Inaccessible RSSs do not include RSSs located in shielding pigs or radiography (gamma camera) units.

incidental XGD—An XGD that emits or produces x-rays during normal operation in which the x-rays are an unwanted byproduct of the device's intended purpose. **Guidance Note**: The x-rays are produced only when electrons are accelerated under vacuum, are not put to any constructive use in a particular application, and are not intentionally conveyed beyond the contiguous vacuum in which they are produced.

Examples: Electron microscopes that operate at greater than or equal to 40 kiloelectron volts (keV) electron kinetic energy; video display terminals; high-voltage electron guns (cathode ray tubes) or electron pulse generators; electron beam welders; high-voltage switches and power supplies; field emission electron beam diodes; televisions; ion implantation devices; electron beam furnaces; magnetrons, klystrons, and other radiofrequency (RF) tubes; Auger electron generators; and vacuum ion sputterers.

individual—Any human being.

infrequent or first-time activities—Radiological work activities or operations that require special management attention and consideration of new or novel radiological controls. The designation of infrequent or first-time activities applies specifically to facilities that conduct routine and recurring process operations, and does not apply to facilities that routinely conduct first-time activities, such as experimental or research facilities.

instrument—A complete system designed to quantify one or more particular ionizing radiation or radiations.

integrity test—Also called a "leak test" (see definition below).

intentional XGD—A category of XGD typically housed within a fixed, interlocked, and/or shielded enclosure/room, specifically designed to intentionally produce and convey beyond the vacuum surrounding the electron acceleration chamber ionizing bremsstrahlung and/or characteristic x-ray radiation that are then used for purposes of imaging, analysis, or research for which such radiation is essential to the process.

Example of facilities housing: conventional (Coolidge) XGDs; magnetic induction devices (betatrons) used to intentionally produce x-rays; electron linear accelerators (LINAC) used to produce x-rays; portable and fixed flash XGDs; analytical XGDs; cabinet XGDs; and Van de Graaff generators used to intentionally produce x-rays.

interlock—A connection between devices that makes the state of one dependent on the state of the other, usually in the context where one state of the interlock causes the controlled device to mitigate the hazard; a device for preventing access to a radiation hazard area either by preventing entry or by automatically removing the hazard when the device is actuated. **Guidance Note**: The safety function of an interlock is to prevent personnel access from outside to the inside of a radiation exposure room/enclosure when x-rays or other types of radiation (for example, accelerator beam) are being generated.

job-specific training—Training required for a worker to perform a particular job.

Joint Tactical Operations Team (JTOT)—A Department of Defense team augmented by LANL personnel involved in the search for and disabling of terrorist nuclear devices.

knowledge of process (KOP)—A method used to characterize waste through knowledge of the material origin, any processes involved, storage of the material, use of the material, and the segregation of the material from potential radioactive contamination. See also *acceptable knowledg*e, which is the preferred terminology.

LANL—Los Alamos National Laboratory

LANL-owned RSSs—RSSs (see definition below) that do not have to be licensed by the NRC or an NRC Agreement State. **Guidance Note**: Johnson Controls Northern New Mexico (JCNMM) is authorized to procure and possess RSSs that are owned by LANL.

LANL-owned XGD—XGDs owned by LANL that do *not* have to be licensed or authorized by the New Mexico Office of Radiological Control. XGDs purchased by Johnson Controls Northern New Mexico (JCNMM), as the primary infrastructure contractor to LANL, are "LANL-owned" in the sense that they do not have to be licensed or authorized by the state of New Mexico Office of Radiological Control.

large-area-swipe survey—Qualitative survey for detecting the presence of removable contamination by wiping Masslinn (or an equivalent material such as cheese cloth) over at least 1000 cm of the surface and counting the residual activity on the Masslinn with an appropriate portable radiation survey instrument.

lead RCT—The RCT who is assigned the primary responsibility for radiological controls at a facility.

leak test—Also called an "integrity test," determines if a sealed radioactive source is leaking radioactive material; a procedure used to evaluate whether the integrity of the source bonding or encapsulation has been breached in such a way that RAM can escape.

level I clothing—One pair of coveralls, two pairs of anti-C gloves (inner pair taped), one pair of booties, and skull cap (or hood).

level II clothing—Two pairs of coveralls, two pairs of anti-C gloves (inner pair taped), two pairs of booties, and hood.

lifetime dose—Total occupational exposure over a worker's lifetime, including external and committed internal dose.

likely—Having greater than a 50% probability of occurrence within a defined period of time, typically a year.

long-term RSS storage area—A designated, secure storage location for RSSs, physically separate from any "active RSS storage area," wherein RSSs no longer routinely used are stored and secured.

low-level radioactive solid waste—Waste material that has been contaminated or activated in excess of established limits and has not been classified as high-level waste, transuranic waste, spent fuel, or mixed waste.

LRACS—Los Alamos National Laboratory Radioactive Sealed Source Accountability and Control System, an unclassified database system developed and maintained by ESH-12 for use by SCs as the single, official Laboratory-wide means of accounting and controlling RSSs/GCs containing RAM/and machine neutron generators accountable under this LIR.

machine neutron generator—An electrical device that accelerates deuterons to kinetic energies of a few hundred kilovolts within an evacuated cavity into either a deuterated or tritiated target material to produce pulses of neutrons or a device in which photons are used to liberate neutrons from a low-Z target material.

MASS—Materials Accountability Safeguards System, an accountability/control database system driven by DOE Order 474.1 that accounts for stockpile amounts of certain radioactive and nonradioactive isotopes, in sealed or unsealed form, useful in nuclear weapons.

member of the public—An individual who is not a general employee. **Guidance Note**: An individual is not a "member of the public" during any period in which the individual receives an occupational dose.

minimum detectable activity (MDA)—The minimum activity, above background, that can be detected with any specific instrument based upon the instrument and technique used.

minimum detectable count rate (MDCR)—The minimum count rate, above background, that can be detected with a stated confidence level using appropriate instruments and techniques.

minor—An individual who is less than 18 years of age.

mixed waste—Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resources Conservation and Recovery Act, respectively.

modification—Any alteration by LANL or the XGD manufacturer of the shielding configuration or XGD or XGF operating practices, or the replacement of the original XGD (or component part thereof) with another that has not been previously evaluated, inspected, monitored, and documented by the RPO. **Guidance Note**: This definition also includes collocation of additional or multiple unevaluated XGDs within a previously evaluated XGF.

monitoring—Measuring radiation levels, airborne radioactivity concentrations, radioactive contamination levels, quantities of radioactive material, and individual doses and using the results of these measurements to evaluate radiological hazards or potential and actual doses resulting from exposures to ionizing radiation.

NIST—National Institute of Standards and Technology

no detectable activity (NDA)—activity that is less than the minimum detectable activity (< MDA).

nonmedical accelerator facility—A machine, commonly housed within a fixed supporting structure, designed to *intentionally* increase the kinetic energy of stable charged particles or ions wherein

(1) Particle/ion kinetic energy is increased via an electric field within specially designed evacuated or plasma-filled acceleration components, and beam collimation and steering is achieved via a concomitant magnetic field acting beyond or between the acceleration components;

(2) Any particulate or other radiation produced within—and/or discharged beyond—the contiguous vacuum that creates a radiological area caused by prompt (beam "on") particles/ions or beam radiation and/or induced radioactivity from beam interactions with targets where significant portions of the whole body (as opposed to the extremities) could be exposed;

(3) The resultant particulate or other radiation produced in and discharged beyond the contiguous vacuum into free space that consists of ionizing radiation other than x-ray photons intentionally produced for x-ray applications; and

(4) Any unsealed radioactivity produced by the accelerator facility, other than fixed activation products, is present in amounts sufficient to determine the hazard category and conduct an accident analysis based on the total amount of unsealed, nonactivation product radionuclides contained within the facility.

Examples: free-electron lasers (FEL) given that such devices can produce radiation other than ionizing x-ray photons; the Stanford Linear Accelerator (SLAC); the Los Alamos Neutron Science Center (LANSCE) facility; cyclotron, synchrocyclotron, and isochronous cyclotron facilities; and single and tandem Van de Graaff generators and ion LINAC facilities, when used to produce and discharge into free space ionizing radiation other than photons, are considered to fall under this definition provided they meet criterion (2), above.

Specifically *excluded* from this definition are facilities housing

(1) Devices that accelerate electrons for the purposes of intentional x-ray production. Such devices include some Van de Graaff generators, electron LINACs, flash x-ray machines, and betatrons used, for example, in nondestructive testing (NDT); and

(2) Various electronic devices that contain within vacuum a source of electrons and an accelerating potential difference that produce ionizing radiation as an incidental/unwanted byproduct of their primary function (for example, electron microscopes that operate at 100-keV-electron kinetic energy or less; video display terminals;

televisions; ion implantation devices; electron beam furnaces; magnetrons, klystrons, and other radiofrequency (RF) tubes; Auger electron generators; vacuum ion sputterers; low-voltage machine neutron generators.

nonstochastic effects—effects caused by radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation-induced opacities within the lens of the eye).

NRC—Nuclear Regulatory Commission

nuclear criticality—A self-sustaining chain reaction, i.e., the state in which the effective neutron multiplication constant of a system of fissionable material equals or exceeds unity.

occupational dose—An individual's ionizing radiation dose (external and internal) that is received as a result of that individual's work assignment. Occupational dose does not include doses received as part of a medical procedure or doses resulting from background radiation or participation as a subject in medical research programs.

off-site shipment—Movement of hazardous material beyond the confines of the LANL site to another location.

on-site transfer—Movement of hazardous materials out-of-doors between buildings or locations on the LANL site over roadways to which the public does not have uncontrolled access. Examples are roadways behind a security gate or Pajarito Road when it is closed to the public.

open intentional XGD installation—An intentional XGD installation that meets the radiation safety requirements specified in ANSI N43.3 (referenced in chapter 18, Part 3). **Guidance Note**: Such installations typically provide little protective shielding for the operator, such as an XGD used outdoors.

open-beam intentional XGD—An analytical XGD that has one or more x-ray paths (primary or diffracted beams) not fully enclosed and that meets the radiation safety requirements specified in ANSI N43.2 (referenced in chapter 18, Part 3).

operational check—Any check or test of an instrument to determine if that instrument is operating acceptably. *Note: The definition is different for ESH-1 procedures.*

operation-specific training—The training required for a worker to perform a particular aspect of a job or unique operation.

other authorized x-ray safety support personnel—Personnel, typically HPs having professional training in the field of health physics, who have described to their group leader in writing their credentials, professional experience, and job capabilities in enough detail to convince the group leader to certify in writing under LIR300-00-01, "Safe Work Practices," that the personnel are qualified and authorized to provide x-ray safety support to LANL on-site and/or off-site x-ray operations.

out-of-service RSS—RSSs (see definition below) that are not anticipated to be used before 6 months or longer that can be taken "out-of-service" and segregated in a secure "long-term RSS storage area."

performance check or *performance test*—A test of an instrument to determine if (1) its response is within a stated acceptable range, (2) any alarms associated with the instrument correctly actuate, and (3) the instrument is otherwise operating acceptably. *Note: The definition is different for ESH-1 procedures*

personal protective equipment (PPE)—Equipment such as booties, anti-C overalls, gloves, respirators, face shields, and safety glasses used to protect workers from excessive exposure to radioactive or hazardous materials.

person—Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, government agency; any state or political subdivision of, or any political entity within a state; any foreign government or nation or other entity; and any legal successor, representative, agent, or agency of the foregoing;

provided that person does not include the Department of Energy or the United States Nuclear Regulatory Commission.

personnel dosimetry—Devices designed to be worn by a single person to assess dose equivalent. Such devices include film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

personnel monitoring—Systematic and periodic estimate of radiation dose received by personnel during working hours; the monitoring of personnel and their excretions, skin, or any part of their clothing to determine the amount of radioactivity present.

photon—A quantum of electromagnetic radiation irrespective of origin.

planned special exposure (PSE)—Preplanned, authorized, infrequent exposure to radiation, separate from and in addition to the annual dose limits.

potential for exposure—A basis for determining the effort to apply a graded approach to the ALARA program. The table in Appendix 3A shows how organizations and facilities are categorized.

PPE—personal protective equipment.

prefilter—Filter that provides first-stage air filtration to remove larger particulates and prolong the efficient use of a HEPA filter.

prenatal radiation exposure—The exposure of an embryo/fetus to radiation.

primary dosimeter—A dosimeter worn on the body to obtain a formal record of whole-body radiation dose.

prompt radiation—Radiation resulting from the accelerator beam or the interaction of the accelerated beam with surrounding matter. **Guidance Note**: Prompt radiation ceases to exist shortly after the beam is removed, typically in less than one second. Radiation emitted from residual radioactivity is not considered prompt radiation.

protective clothing—Clothing provided to personnel to minimize contamination to the skin and to personal and company-issued clothing. Also referred to as "anticontamination clothing," "anti-Cs," and "PCs."

public—Any individual or group of individuals who is not occupationally exposed to radiation or radioactive material. An individual is not a "member of the public" during any period in which the individual receives an occupational dose. Also see *member of the public*.

qualitative—In the context of performing a contamination survey, refers to measuring contamination without reliably measuring the amount of contamination present. **Guidance Note**: Qualitative survey results are *not* used to establish posting requirements or to release materials or areas. Large area swipes and direct floor monitor surveys are qualitative surveys used mostly for the following reasons:

- as a means of promptly assessing whether low-level fixed or removable contamination exists in an area,
- to quickly delineate a contamination boundary,
- for surveying when hot particles are a potential problem, and
- for routine surveys of uncontrolled areas, radiological controlled areas, or radiological buffer areas.

quantitative—In the context of performing a contamination survey, refers to measuring both the presence and amount of contamination present. **Guidance Note**: Quantitative surveys are used to establish posting requirements, and to release materials or areas. Smear surveys and direct surveys, taken with hand-held instruments, are quantitative surveys used to reliably measure contamination levels.

radiation—Ionizing radiation, which is alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation as used in this LIR does not include nonionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation area—Any accessible area in which radiation levels could result in an individual's receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

radiation interlock—A radiation detection device that turns an accelerator beam off or returns a source to its enclosure when radiation levels at predetermined locations exceed a preset dose rate.

radiation protection organization (RPO)—The groups (ESH-1, ESH-4, ESH-12, and radiation protection team of ESH-13) responsible for defining and implementing the occupational radiation protection program at the Laboratory.

Radiation Protection Program manager—The individual responsible for overall direction of the Laboratory's occupational radiation protection program.

radiation survey—Measurement with instrumentation to evaluate and assess the presence of radioactive materials or other sources of radiation under a specific set of conditions.

radiation worker—same as radiological worker

radioactive material—Any material, equipment, or system component determined to be contaminated or suspected of being contaminated. Radioactive material also includes activated material, sealed and unsealed sources, and material that emits ionizing radiation. For transportation purposes (DOT definition), radioactive material is material with a specific activity that is greater than 0.002 µCi/g (> 2 nCi/g).

radioactive material area—Any area, accessible to individuals, in which items or containers of radioactive material are present and the total activity of radioactive material exceeds the applicable values listed in Appendix 16A of this LIR.

radioactive material transportation—The movement of radioactive material by aircraft, rail, vessel, or highway vehicle when such movement is subject to DOT regulations or DOE orders that govern such movements. **Guidance Note**: Radioactive material transportation does not include preparation of material or packagings for transportation, monitoring required by 10 CFR Part 835, storage of material awaiting transportation, or application of markings and labels required for transportation.

radioactivity—A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.

radiography—Examining the structure of materials by nondestructive methods, using a radioactive source or a radiation-generating device.

radiological ambient conditions—The average radiological conditions that exist in an area, including dose rates, surface contamination levels, and airborne radioactivity levels.

radiological area—Any area within a controlled area defined in this section as a "radiation area," "High Radiation Area," "Very High Radiation Area," "Contamination Area," "High Contamination Area," or "Airborne Radioactivity Area."

Radiological Buffer Area (RBA)—An area within a Radiological Controlled Area and outside a radiological area that provides a second boundary to minimize personnel exposure and the spread of contamination. **Guidance Note**: This area surrounds or is contiguous with Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, Radiation Areas, High Radiation Areas, or Very High Radiation Areas.

radiological control hold point—Cautionary step in an RWP or technical work document in which work is stopped and the RCT or **HPT** performs some action or verification.

radiological control personnel—individuals within the radiation protection organization (RPO).

radiological control technician (RCT)—A person who has been trained in the RCT training program at LANL, whose RCT certification is current, and who is assigned to or authorized by the ESH-1 Health Physics Operations group to provide radiological safety support. Also called radiological worker or radiation worker.

radiological incident—Any unexpected event resulting from the use of radioactive materials or radiation-producing equipment that meets the criteria specified on the RIR (Radiological Incident Report) form and summarized in the reporting levels table (in LIR201-00-04, "Los Alamos National Laboratory Incident Notification Process").

radiological occurrence—An event or condition to be reported in accordance with DOE Order 232.1, Chg 2, "Occurrence Reporting and Processing of Operations Information," with the ESH-7 *Occurrence Investigating and Reporting Manual*, or with ESH-7 guidance.

radiological posting—Sign, label, or tag that indicates the presence or potential presence of radiation or radioactive materials.

radiological work—Any work that requires the handling of radioactive material or radiation-producing equipment or which requires access to Radiation Areas, High Radiation Areas, Very High Radiation Areas, Contamination Areas, High Contamination Areas, or Airborne Radioactivity Areas.

radiological (or radiation) work permit (RWP)—Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The radiological work permit serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions.

radiological worker—A general employee whose job involves operating radiation-producing devices or working with radioactive materials or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent.

RAM—radioactive material

RCA—Radiological controlled area.

RCT—radiological control technician

real-time air monitoring—Measuring the concentrations or quantities of airborne radioactive materials on a continuous basis.

redundancy—Duplication or repetition of elements in electronic or mechanical equipment to provide alternative functional channels in case of failure. Two systems are not redundant if there is a possible single shared failure point that would defeat the function of both.

reference man *or reference person*—A person with anatomical and physiological characteristics as defined in ICRP 23.

reference reading—A response established for an instrument to a specified radioactive source, either by calculations or by exposing the instrument to the source in a constant and reproducible manner.

removable contamination—Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or washing.

representative sample—A sample that closely approximates both the concentration of activity and the physical and chemical properties of material (e.g., particle size and solubility in the case of air sampling of the aerosol to which workers may be exposed).

reproducibility (precision)—The degree of agreement of repeated measurements of the same property expressed quantitatively as the standard deviation computed from the results of the series of measurements.

residual radioactive material—Any radioactive material that is in or on soil, air, equipment, or structures as a consequence of past operations or activities.

respiratory protective device—An apparatus, such as a respirator, worn by an individual for the purpose of reducing the individual's intake of airborne radioactive materials.

retrospective air sampling—Collecting air samples over a known period of time with the collected sample analysis performed after the sample collection. The air sample is either collected on a filter, in a cartridge, or in a solution (such as a tritium bubbler).

RMA—Radioactive Material Area

routine radiological work—Work that is performed repetitively on a recurring process or operation that incorporates standard radiation protection requirements and practices based on experiences with the existing radiological conditions.

RPD—radiation-producing device

RPO—radiation protection organization

RPP—Radiation Protection Program; also the 10 CFR 835-required document that contains commitments to DOE to implement each requirement of the rule.

RSS—radioactive sealed source

> **Guidance Note**: The following items and equipment, which may be present at LANL, are not considered to be RSSs under the above definition and need not meet the requirements of this LIR:
>
> "Consumer products" that have been approved by the NRC to contain small amounts of RAM for distribution to the public without a license. Examples include tritium "exit" signs; luminous dial wrist watches/compasses; static eliminator brushes; smoke detectors; thoriated optical glass and lenses; gas mantles; welding rods; fluorescent lamp starters; spark gap irradiators; plutonium-powered cardiac pacemakers; certain ceramics/glassware/dental products containing uranium; and ion (electron) generating tubes.
>
> Foils used for neutron activation; activated shielding/equipment/materials not intended to be further manufactured into RSSs; fission chambers; nuclear reactor fuel elements or critical assemblies; RTGs; closed bottles of radioactive solutions in radiochemistry laboratories or isotope (e.g., technetium) generators; uranium and thorium structures used for shielding, ballast, or counterweights; DU used in aircraft ailerons, elevators, landing gear, or rotor blades or DU used to suppress vibration in petroleum exploration equipment; DU instrument check sources typically used by ESH-1 RCTs; military munitions containing RAM, radioactive commodities used in or on military equipment or RAM contained in armor plate; yellow cake (U_3O_8 or UO_4) in closed shipping containers; enriched UF_6 in containers being shipped; sodium iodide detectors seeded with radioactive ^{241}Am; nonfirmly fixed, dry RAM on calibration plates used to calibrate low-level radioactivity counting equipment; RAM-in-process; radioactive x-ray production targets contained within evacuated cavities; and closed canisters of stored SNM.
>
> Based on DOE's definition of an RSS as stated in 10 CFR 835.2, in which nuclear explosive devices are exempt from being designated as RSSs, no radioactive components (for example, pits, war reserve bottles, and neutron generators) of nuclear explosive devices/weapons or nuclear-like devices/weapons shall be controlled as RSSs.

RTG—radioisotope thermoelectric generator; a device containing SNM, the radioactive decay heat from which is used to produce electrical power.

RWP—A radiation work permit, which is a work planning document used to authorize nonroutine, complex, unusual, or abnormally hazardous radiological work not otherwise described, analyzed, and controlled in an approved HCP.

SC—source custodian; a person trained and authorized by operating group management to control and account for the RSSs owned by that group.

SCO—Source Control Office; an office in ESH-12 that is responsible for maintaining the Laboratory's centralized database of all accountable RSSs/GCs containing RAM/machine neutron generators so that the Laboratory can document and demonstrate compliance to federal law (10 CFR 835). **Guidance Note**: The SCO can be contacted at 665-5298 or through the ESH-12 group office (667-5296).

SCRAM button—An electromechanical device, installed in an x-ray or other facility exposure room or enclosure in which workers enter or exit in the course of x-ray/beam operations, that when manually depressed/activated, prevents or interrupts the production of x-rays/the beam from the XGD or other device. **Guidance Note**: SCRAM buttons are wired to the XGD control panel in such a manner that x-ray production cannot be resumed unless the SCRAM button is reset, e.g., depressed SCRAM button manually pulled back out to the "on" position, and x-ray exposure procedures reinitiated at the XGD control panel. Such safety devices permit workers inadvertently caught inside the x-ray exposure room when x-ray operations commence to prevent or interrupt the production of x-rays to permit their own egress from the exposure room to a shielded location. The acronym "SCRAM" historically meant either "safety control rod ax man" or "sudden control rod activation by manual means." Radiation workers have come to know and use this term interchangeably with the term "emergency off switch." The safety function of a SCRAM button is to prevent the XGD from producing x-rays when workers who are inside the room or enclosure have to quickly exit to a safe location outside the room or enclosure. The SCRAM button has basically the opposite safety function to that of an interlock.

sealed radioactive source—A radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained in a nonradioactive sealed capsule, sealed between layers of nonradioactive material or firmly fixed to a nonradioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. **Guidance Note**: GCs and machine neutron generators containing radioactive material are considered to be RSSs for purposes of accountability and radiological control of the RAM contained in such equipment. Embedded RSSs contained in radiation measuring instruments are also considered to be RSSs for purposes of accountability only. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, or radioisotope thermoelectric generators.

self-contained breathing apparatus (SCBA)—A full-face respirator that supplies air to the wearer from a compressed-air cylinder that is worn on the worker's back.

shield or shielding—Attenuating material used to reduce exposure of personnel to radiation.

shielded intentional XGF installation—An intentional XGF installation that meets the radiation safety requirements specified in ANSI N43.3 (referenced in chapter 18, Part 3). Such installations typically provide a moderate degree of protective shielding to the operator, but the operator typically sustains sufficient annual dose to require individual dosimetry.

smear survey—Quantitative test for detecting the presence of removable contamination. This test is normally performed by wiping a filter paper (or comparable substitute) over 100 cm of the surface and counting the residual activity on the filter with an appropriate laboratory-grade radiation-counting instrument.

SNM—special nuclear material

soil contamination area—An area where the soil is contaminated and is not releasable in accordance with DOE Order 5400.5.

source leak test—A test that determines if a sealed radioactive source is leaking radioactive material.

special protective equipment—Protective clothing items designed or used to provide additional protection against specific hazards expected during the course of work: Saranex 7, ice vest, leather gloves, lead apron, and so forth.

special radiological work—Work that is either first-time, "nonroutine," or complex; and exceeds trigger levels (see Appendix 3B). Special radiological work requires additional planning, review, and determination of radiation protection precautions to be provided for the worker's safety.

step-off pad—An area established at access points to *Radiological Controlled Areas, Radiological Buffer Areas, Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, or Hot Job Exclusion Areas* used for donning and removing protective clothing. **Guidance Note**: Step-off pads should be large enough to accommodate such activity, may be labeled with protective clothing requirements, and may be layered with adhesive material to help control contamination. Step-off pads should normally be kept free from contamination and verified as such.

stochastic effects—Malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold for radiation protection purposes.

subcontractor-owned RSS—RSSs owned and possessed under a specific license issued to the subcontractor by either the federal NRC or an NRC Agreement State.

subcontractor-owned XGD—XGDs owned and possessed under an authorization issued to the subcontractor by an NRC Agreement State, such as New Mexico, or by the Office of Radiological Control of a non-Agreement state.

supplemental dosimetry *or secondary dosimetry*—Dosimetry used in addition to primary (whole body) TLDs. Supplemental dosimetry may include extremity dosimetry such as finger rings and electronic dosimetry.

supplied-air suit *or bubble suit*—A suit that covers the entire body and supplies breathing air to the wearer from an independent air supply.

survey—Evaluating the radiological conditions and potential hazards incidental to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

swipe survey—Qualitative test for detecting the presence of removable contamination. This test is normally performed by wiping Masslinn or equivalent over at least 1000 cm of the surface and counting the residual activity on the Masslinn with an appropriate portable radiation survey instrument.

SWP—special work permit

tamper-proof—Containment that prevents unintentional access to access-control system hardware.

temporary shielding—Shielding that is constructed for (1) one run cycle (such as at an accelerator facility), (2) the duration of a single experiment, or (3) a job that lasts less than one year. It is also shielding that is reconfigured to accommodate a new experiment or modify an existing experiment.

thermoluminescent dosimeter (TLD)—Radiation monitoring device used to record the radiological exposure of personnel or areas to certain types of radiation.

transuranic waste—Without regard to source or form, waste that is contaminated with alpha-emitting radionuclides with an atomic number greater than 92 and having half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay.

unaccountable RSS—an RSS whose decayed isotopic activity is less than the corresponding value listed in Appendix 16A of this LIR or whose radioactive half-life is less than 30 days.

unattended intentional XGF installation—An intentional XGD installation that meets the radiation safety requirements specified in ANSI N43.3 (referenced in Chapter 18, Part 3). **Guidance Note**: Such installations are designed for a specific purpose and do not require personnel in attendance.

uncontrolled area—An area to which access is *not* controlled for radiological purposes. The radiological ambient conditions are essentially natural background.

Underground Radioactive Material Area—Underground areas that contain radioactive materials such as pipelines; radioactive cribs; covered ponds; covered ditches; catch tanks; inactive burial grounds; or sites of known, covered, unplanned releases (spills).

Very High Radiation Area—Any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

visitor—Member of the public requesting access to radiological controlled areas who has not been trained to the level that would permit unescorted access. Visiting scientists and others who visit the Laboratory to perform work are considered general employees.

volume-contaminated material—any item or material that contains radioactivity within it's volume due to either activation (e.g., neutron activation) of the atoms within the item or material or by the incorporation of radioactive material into the volume of the item or material (e.g., mixing of radioactive material into pulverized concrete).

week—A period of seven consecutive days.

work group supervisor—The individual responsible for directing a work group activity (that is, group leader, deputy group leader, team leader, or coworker).

work planner—The individual who coordinates personnel and equipment to get work done.

XCO—XGD/XGF control office; an office in ESH-12 charged with the responsibility of establishing XGD program requirements to (1) provide instrumented XGF radiation safety surveys, (2) perform XGF shielding evaluations, and (3) serve as the central LANL point-of-contact and office of record for the Laboratory-wide management and control of XGDs/XGFs as mandated by DOE.

XGD—X-ray-generating device; a device that produces x-rays. **Guidance Note**: The universe of XGDs can be subdivided into two categories— intentional XGDs and incidental XGDs.

XGF—X-ray-generating facility; the combination of an intentional XGD and its immediate, surrounding, interlocked, shielded enclosure or room. **Guidance Note**: The universe of XGFs can be subdivided into classes based on the dose rate coming through the facility shielding to which XGD operators may be exposed.

XGD/XGF custodian—A person trained and authorized by the operating group leader responsible for the safe use and control of the XGDs/XGFs owned by that group. **Guidance Note**: An XGD/XGF custodian may also be an XGD/XGF operator.

XGD/XGF operator—An individual authorized by the operating group leader and qualified by training and experience to operate specific XGDs/XGFs owned by the group.

year—The period of time beginning on or near January 1 and ending on or near December 31 of that same year used to determine compliance with the provisions of 10 CFR Part 835, November 4, 1998. The starting and ending date of the year may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.